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Forthcoming Events.

DECEMBER 14.

Institute of British Foundrymen (London Branch):—Annual dinner, Engineers' Club.

Institute of British Foundrymen (Scottish Branch):—Ordinary meeting at Glasgow. "A Talk on Scientific Brass Foundry Work," Paper by P. Longmuir, D.Met.

Institution of Electrical Engineers (Students' Section, Scottish Centre):—Ordinary meeting at Glasgow. "Insulating Material," Paper by J. A. MacNaughton.

Institution of Mechanical Engineers:—Ordinary meeting in London. "Exhaust Valve and Cylinder Head Temperature in High-Speed Petrol Engines," Paper by Professor A. H. Gibson and H. Wright Baker, M.Sc.

Institute of Metals (Sheffield Local Section):—Ordinary meeting at Sheffield. "The Metallurgical Microscope—Some Notes on its Construction and Use," Paper by J. H. S. Monypenny.

DECEMBER 15.

Institute of British Foundrymen (Newcastle-on-Tyne Branch):—Ordinary meeting at Newcastle. "Green Sand Moulding" Paper by J. D. Nicholson.

Institution of British Foundrymen (Scottish Branch):—Ordinary meeting at Glasgow. "A Talk on Scientific Brass Foundry Work," Paper by P. Longmuir, D.Met.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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The Utilisation of Turnings.

Attempts to utilise turnings have materially influenced metallurgical progress in the last decade. It is no exaggeration to say that the electric melting of steel owes most of its success to its ability successfully and economically to use turnings as a raw material. The character of steel turnings varies considerably. They can exist as short chips or as long spirals. The latter can cause hours of wasted time associated with important monetary losses, owing to the formation of tangles, which prevent rapid shovelling. It is no uncommon occurrence to see workmen using their shovels to cut up these tangles, followed by raising the furnace door to its limit to charge in, with the aid of his mates, what amounts to an odd pound or so. Messrs. Thwaites, of Bradford, found it worth while to break down such turnings in a pug-mill in order to obviate this waste of time in charging.

Attempts have also been made to briquette steel turnings, but owing to their springy nature, the briquettes we have seen are of poor mechanical quality. Most electric furnaces have at some period melted cast-iron turnings, but unless the furnace is very high-powered the operation is slow and costly, as the pools of metal formed do not attack and render liquid the surrounding walls of turnings. The theory of this we do not propose to discuss, beyond saying that highly superheated liquid cast iron does not quickly assimilate solid cast iron when operating under a reducing atmosphere.

The briquetting of cast-iron turnings has never been a general commercial success, and the method outlined by Mr. J. Alex. Gardner elsewhere in this issue is of the greatest importance. It constitutes a real advance in the economic metallurgy of cast iron. We cannot say that we agree with Mr. Gardner's metallurgical conclusions, as we are of opinion that he has emphasised too much the influence of clay and too little the influence of the water. We suggest that whilst the action of the former is almost mechanical, that of the latter is chemical. In a hundred pounds of turnings several square miles of surface are exposed to oxidation, and obviously must have a profound result on the dried briquette. The clay, being highly refractory, we envisage would become mechanically mixed with the slag, though it is quite possible one molecule of SiO_2 may be released to combine with the lime of the limestone and ferrous oxide to form silicates. However, the process outlined is excellent in conception and economical in operation, and is one which should be seriously considered by every large foundry. The large savings which can be effected can readily be gauged when it is stated that one of the largest engineering works in England is actually paying for cast-iron turnings to be carted away from the works. Whilst it is yet too early to be dogmatic, there is sufficient evidence available to show that if the results obtained by Mr. Gardner can be universally reproduced, a considerable national economy will be effected. Previous to the experiments outlined, the use of cast-iron borings was liable to give results of such an uneven character that any saving was distinctly doubtful.

The question of non-ferrous turnings is relatively simple. They merely require melting, casting, and the resultant ingots analysing, and using according to the results shown; but this, of course, with discrimination.

"Moulders" of the Industry.—No. 23.

Professor Thomas Turner, Feeney Professor of Metallurgy in the University of Birmingham, and President-designate of the Institute of Metals, is the doyen of metallurgical professors in this country and one of the most renowned metallurgists in the world, his name being as well known in America as in Europe.

Born in Birmingham in 1861, he completed his professional training at the Royal School of Mines, where he was De la Beche medallist, becoming demonstrator in chemistry at Mason College—afterwards the University of Birmingham—in 1883, lecturer in metallurgy in 1887, and first Professor of Metallurgy in 1902. In that year he visited Canada and the United States, and inspected the metallurgical equipments of the great American Universities. As a result, on his return to this country, he was in a position to design for Birmingham University the finest Metallurgical Department to be found in this country. For two years Professor Turner supervised the building and equipment of his new Department—a model that has been copied far and wide, and which has been the academic home of a band of distinguished metallurgical workers whose names are known throughout the profession.

Amongst those who have been students under him in the Metallurgical Department of the old Mason

PROFESSOR THOMAS TURNER.

College were the Prime Minister, the Rt. Hon. Stanley Baldwin, also the Chancellor of the Exchequer, the Rt. Hon. Neville Chamberlain. Mr. Baldwin was associated with his father's business near Stourport, and familiarised himself with the metallurgical technique of the trade by his studies at Birmingham. The days when he sat at the feet of Professor Turner were happily recalled in a recent letter from the Prime Minister, in which he congratulated the Professor upon the honour just conferred upon him by the Institute of Metals in nominating him as its President. Two other well-known men who studied metallurgy under Professor Turner were Sir Henry Fowler, K.B.E., a splendid example of the engineer who has a thorough working knowledge of the metallurgy of the ferrous and non-ferrous materials that he is called upon to handle, and the late Professor A. McWilliam, of Sheffield. Among the newer generation of Birmingham University metallurgists may be mentioned such old students of Professor Turner as Dr. J. L. Haughton, of Woolwich Arsenal; Mr. H. I. Coe, of Swansea; Principal D. H. Ingall, of Wednesbury; Dr. F. Johnson, of Birmingham; Professor O. W. Ellis, of Toronto; and Mr. G. Shaw Scott, the Secretary of the Institute of Metals—the latter, by the way, Birmingham's first graduate in metallurgy, as his wife, a daughter of Professor Turner, was the first woman to take metallurgy for her B.Sc. degree.

These few names serve to show the type of workers that Birmingham University has turned out under the stimulus of Professor Turner's example. He has always been most assiduous in helping on his students in their work, and in suggesting to them new and useful lines of investigation; his encouragement is always gratefully remembered. As Sir Robert Hadfield said recently, "A more true and faithful worker in the cause of metallurgy does not exist." The occasion of this very just estimate of Professor Turner's activities was an interesting one, coinciding as it did with the bestowal upon Sir Robert of the Thomas Turner Gold Medal for his distinguished work on behalf of the science of metallurgy. The Thomas Turner Gold Medal, Bronze Medal and book prize came into existence in 1920, as a result of the benevolence of a Birmingham manufacturer, who was so impressed with the value of Professor Turner's metallurgical work—particularly in reference to the effect of silicon upon cast iron—that he desired it thus to be commemorated in perpetuity.

It was in connection with his researches on the influence of silicon and other elements on iron and steel—the results of which have been largely applied in iron foundries throughout the world—that Professor Turner first became famous, his paper on "Alloys of Iron and Silicon" before the Iron and Steel Institute in 1889 having become a classic. Another important paper was that on "Aluminium Steel" in 1890. His papers on the structure, hardness, and volatility of metals and alloys before the Institute of Metals, Iron and Steel Institute, the Institute of British Foundrymen, and other bodies have been numerous and important, these culminating in the May lecture on "The Casting of Metals," delivered before the Institute of Metals in 1921.

Professor Turner's association with the Institute of British Foundrymen has always been of the closest, and he is now an honorary member. He was one of the small body of enthusiasts who founded the Institute of Metals in 1908, and was a member of the original Council of the Institute and its first Treasurer, an office that he held for six years. On retiring from the Treasurership the members showed their appreciation of Professor Turner's services by electing him a Vice-President, a dignity which is about to be changed to that of President.

In his new and very important office—especially important in 1924 in view of the association of the Institute with the Empire Mining and Metallurgical Congress to be held in connection with the British Empire Exhibition—we wish Professor Turner the success that we feel assured will be his.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The Decline of Semi-Steel.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I have read with much interest the recent correspondence on the decline of steel-mix irons, and agree with both "Cupola's" and Mr. E. Wheeler's remarks.

In the direct melting of steel-mix irons, unless absolute scientific cupola control can be exercised, trouble is liable to occur, especially in the class of work usually running in jobbing foundries. This trouble is usually in the nature of quick falling metal, shrinkage under misplaced runners and risers, excessive oxidation and other inherent defects which quickly arise. These troubles are augmented when low-silicon irons are used, and it has been found that the utilisation of low-carbon special pig-irons, which are usually steel-mix irons, give that freedom of working so necessary in jobbing work. In the writer's opinion the melting of these special irons give the nearest approach to a "fool-proof" iron as can at present be obtained, with nearly all the properties of direct steel-mix iron.

For specialised work, however, direct steel-mix iron will always be in demand, and if every foundry had an absolute understanding of the placing of runners and risers for steel-mix irons most of the troubles would be eliminated and our foremen melters and metallurgists would not have to fall back on "fool-proof" cast irons.

This absolute misunderstanding, or perhaps very often a misplaced understanding, of the physical properties of steel-mix iron cause trouble in foundries, and they fall back on to these special irons which, in the case of an intelligent man, give excellent results.—Yours, etc.,

FRANK HUDSON.

Close Works, Gateshead.
December 8, 1923

Mechanical Properties of Metals at Elevated Temperatures.

A Paper on this subject was read on December 3 at the Staffordshire County College, Wednesbury, before the Birmingham Metallurgical Society, by the Metallurgical Principal of the College, MR. DOUGLAS H. INGALL, M.Sc. Some researches carried out at the College were dealt with, and a number of practical conclusions and hints, based upon the researches, were offered to manufacturers, as well as to workers of metals.

The author pointed out that at elevated temperatures the tensile, impact and hardness tests had so far received the maximum attention. The object of his Paper was to summarise and co-ordinate the results of elevated-temperature mechanical-tests, and show that important deductions might be made. Up to a given temperature, which might be nearly atmospheric, with low melting-point metals and alloys, little change of mechanical properties was observed. But beyond the given temperature the tensile strength of both ferrous and non-ferrous materials fell in a manner compatible with that of a viscous substance. It was known that the rate of application of the load in a tensile test within reasonable limits did not affect the results obtained at ordinary temperatures, but it had been shown that at elevated temperatures a period occurred where the increased rate of loading gave a decidedly higher strength, and that this effect gradually disappeared towards melting point. This rate-of-loading phenomenon would be observed with a viscous material over a period about its softening temperature. The fall of the elastic strength practically to zero, and the rise of ductility towards melting temperature were also in accordance with the behaviour of a plastic substance when stressed relatively slowly at temperatures above its softening range.

With regard to impact tests, investigations on steels (ignoring the critical point between 200 and 300 deg. C.) showed a fairly constant value to be obtained with rising temperature up to a point beyond which the values began to increase relatively rapidly. A viscous material would show a low value until a decided softening took place, beyond which its resistance to impact would show a marked increase, falling away again when near the truly liquid state. As steels had not been investigated above 1,000 deg. C., the fall of the impact value near the melting point had not yet been demonstrated. Hardness tests at elevated temperatures showed that the hardness of a viscous substance with rise of temperature would exhibit a decrease at the softening point which would become more and more pronounced with rising temperature; further, the duration of the load in a hardness test would be appreciable beyond the softening temperature. Both these facts had been observed in metals and alloys above their critical inflection temperatures.

In conclusion, the author suggested several applications to industry arising out of the considerations of the viscous condition in metals and alloys at elevated temperatures. (1) The determination of the critical inflection temperature for any given metal or alloy was of the utmost importance, as above that temperature there would always be the liability of the material slowly giving to an applied stress by flow; hence the critical inflection temperature would definitely mark that limiting temperature up to which the material could be used in any structure subject to stresses. (2) The critical inflection temperature would indicate that limiting temperature up to which the wearing qualities of any material or alloy would reasonably be maintained, and would obviously be of some considerable importance in connection with materials used for the construction of moving parts, such as pistons and valves in internal-combustion engines.

(3) In the hot-working of metals our modern industrial methods tended towards increased speed of production. It was well known that a viscous material would deform above its softening point, but that the time-factor was an all-important one, and too rapid an application of the deforming stress would rupture the material. If, in hot-working metals and alloys above their critical inflection temperatures they were behaving partly as viscous substances, it might be quite possible that a number of manufacturing processes had reached a speed of deformation of a given metal or alloy which was the limiting speed for the viscosity of the material at the given working temperature, and perhaps in certain cases it had been exceeded. This would explain the breakdown of material in manufacturing in certain cases, which was usually ascribed to the condition of the material being inferior to the production of years ago. In making such comparisons it would be well to compare manufacturing conditions as well as quality of materials, and in certain cases it might possibly pay somewhat to reduce the speed of manufacture in order to obtain a smaller percentage of scrap.

Institute of British Foundrymen.

NEWCASTLE BRANCH—JUNIOR SECTION.

A meeting was held in the Neville Hall, December 8, Mr. H. F. Clements in the chair.

At the commencement of the proceedings, the President announced that Mr. H. J. Young, F.I.C., had been unanimously elected by the Council and members as Patron of the Junior Section, this announcement meeting with the hearty approval of all present.

Mechanical Testing of Metals.

The above is the title of a joint Paper which was given that night by Mr. H. C. Jay and Mr. W. P. Gospel.

In their lecture the authors pointed out that the science of mechanical testing had been developed as a means of studying the behaviour of metals under specified working conditions. The tests to which the metals were subjected depended upon the character of the material in question and the purpose for which it was intended. The various types of testing machines were fully described by the lecturers and the methods of testing were explained. The question of test-bars was also touched upon, the advantages of bars cut out of castings and bars attached to castings being pointed out.

The Paper aroused an excellent discussion.

Atmospheric Corrosion of Metals.

One of the most important researches on the subject is that being carried out by the Atmospheric Corrosion Committee of the British Non-Ferrous Metals Research Association. Mr. W. H. J. Vernon, B.Sc., the investigator, has just submitted his first experimental report, which was read before the Faraday Society in London on December 17. The work described has been carried out under the supervision of Professor H. C. H. Carpenter, F.R.S., at the Royal School of Mines, and deals chiefly with the initial stages of corrosion—the tarnishing of metals. Quantitative measurements have been made on the relative behaviour of different metals and alloys both indoors and outdoors. The subject is of great importance, not only to those who are concerned in the manufacture of metal fittings and articles, but in its direct relation to labour-saving in daily housework. The investigation is by no means confined to tarnishing, which forms the outstanding feature of the first report, merely because it represents the initial stage of corrosion. Exposure tests to outside atmospheric influences have been progressing since the commencement of the research, and will doubtless yield their quota of evidence in due course. The extension of this work depends to a large extent on the support given to the British Non-Ferrous Metals Research Association for this specific purpose; the investigation already has the backing of the Royal Institute of British Architects, the Department of Scientific and Industrial Research, and many of the leading firms and Associations in the metal industry.

SCHNEIDER & COMPANY, of Le Creusot, are raising their share capital to 50,000,000 fcs. by (1) drawing 4,000,000 fcs. from their reserve fund and raising the nominal value of each of the 100,000 old shares from 300 fcs. to 400 fcs., and (2) issuing 25,000 new shares of 400 fcs. each, present shareholders taking preference in acquiring these.

XUM

The Preparation and Testing of Moulding and Core Sands.*

By E. M. Currie, A.I.Brit.F.

There has been within the last three years a great amount of investigation carried out on the properties, occurrences and characteristics of moulding and core sands, especially artificially-bonded sharp sands for core making, and the author does not profess to be able to add much more information to that already published, but rather he has tried to set down his observations and a few results in connection with the preparation and testing of sands, with special reference to those used in the iron foundry.

It is rather unfortunate that a great many founders cannot yet overcome their antipathy to any research of this nature, especially considering that no very expensive apparatus is necessary. The improvements in the resultant castings more than compensate for any slight inconvenience this may entail.

America particularly has realised the immense gain to be derived from the systematic study of sand, and their natural resources require extensive study to prepare the best available material in the most economic way to suit peculiar requirements of the mass production of their specialised foundries, but it should be remembered that the researches of Boswell, Holmes, and others in this country have very materially increased the information on sands that we now possess.

The Chemical Aspect of Sand.

Realisation of the characteristics of the various constituents of a sand is an aid to obtaining maximum efficiency from a particular sand;

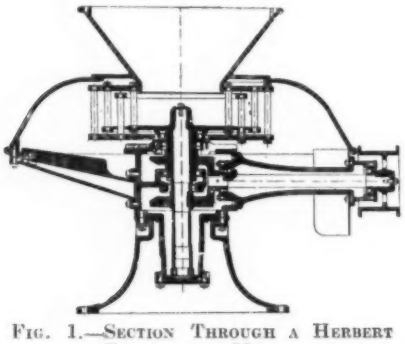

FIG. 1.—SECTION THROUGH A HERBERT CENTRIFUGAL MIXER.

so that chemical analysis, although not absolutely necessary, is of importance when studying the physical properties.

Sand is the result of the natural disintegration of granite, and consists more or less of three distinct substances:—Quartz, practically pure silica, the main constituent, which imparts a quality of refractoriness to the sand.

Feldspars, which consist of combinations of sodium and potassium oxides, lime, magnesia, together with some silica and alumina; but these in quantity are undesirable materials, as they reduce the heat-resistance properties of the sand by forming fusible slags under the action of the molten metal.

Clay, responsible for the bond of the sand, consists of a combination of alumina and silica, together with hydrated oxide of iron and some organic matter.

For iron, a moulding sand usually contains from 80 to 90 per cent. silica, 4 to 10 per cent. alumina, 0.5 to 1.5 per cent. lime, approximately 0.5 per cent. magnesia, under 5 per cent. iron oxide, and the alkalies together not exceeding 3 per cent. For most non ferrous metals the sand may contain higher percentages of iron and lime without detriment. The greater the amount of silica, the more refractory is the sand, but a sand with a high percentage of silica, say over 90 per cent., is deficient in natural bond.

The main part of the bond is supplied by the alumina, the quantity of which is important, as an excess of alumina—under which conditions an excess of organic matter is also likely to be present—tends to reduce porosity, a most desirable quality in sand. It is essential also to note the percentage of iron as iron oxide, as although it aids the bond by its property of retaining moisture, in the presence of the other elements, it tends to form a slag.

The Mechanical Testing of Sand.

Mechanical analysis is probably more easily interpreted by the practical man, to whom a knowledge of the proportions of the grain sizes is of value in comparing different qualities of sand. There has been a great deal of controversy over this test, and many widely varied methods have been put forward. By this it is meant that the principle of the methods is identical, but the procedure differs. A dissertation on this would occupy too much time, but it is intended to mention the two main methods, which will be designated as the dry and wet methods.

In the latter a weighed quantity of dry sand is mechanically agitated with water for some time, and then washed through sieves of 30, 60, 90, 100 and 200 mesh with a jet of water. The contents of each sieve is then dried and weighed, and the amount retained on each is given as a percentage. The alternative method is to dry the sand at 105 deg. C. for approximately an hour, and is then graded through the sieves until no more will pass

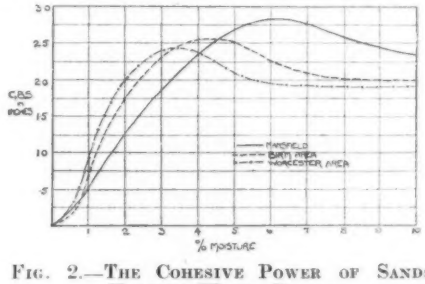

FIG. 2.—THE COHESIVE POWER OF SANDS VARYING WATER CONTENT.

through each, and the percentages retained on each is again determined.

By this method the grain size is obtained larger than it really is, due to the coating of the larger grains by the silt and clay, *i.e.*, through 200-mesh grade, so that while there is much to be said in support of the wet method (including elutriation, for accuracy), there is no necessity from the founder's point of view to adopt these refinements, and the dry method will yield all the information necessary.

It is easy to understand that a sand of rounded grains of uniform size is far superior to one which has its permeability impaired by a large quantity of small grains packed in between the larger ones, and as the smaller grains contain relatively larger proportions of the impurities—that is, the alumina, iron oxide, lime, and the alkalies—it will be seen that refractoriness is impaired, and is liable to cause trouble due to the burning-on of the sand. Viewed from the moulders' standpoint, fine-grained sand is preferable, as it gives a good surface finish when being tooled.

Sand Mixing.

It is only within the last fifteen years that sand-mixing apparatus has had the attention it deserves. An even distribution of a thin coating of the bond on the sand grains is the aim of mixing, but the mechanical means available for doing this introduce other conditions.

* Paper read before the Coventry Branch of the Institute of British Foundrymen, Mr. C. Dicken presiding.

Pan mills, once regarded as the most efficient machines for mixing, have undergone many modifications, notably the substitution of a cogged for a plain roller. This ensures a more perfect blending without exercising a crushing action on the grains, which develops the evil of loss of permeability, and which necessitates the use of more tempering agent and additional bond. The general effect of milling, as is well known, is to toughen the sand by even distribution of the bond, but a great disadvantage lies in slowness of operation; and whereas it is necessary, in the case of sands for steel or synthetic moulding sands, it can be dispensed with for iron. With the large quantities of sand dealt with in iron foundries, it has been recognised as necessary to adopt a more speedy and economical means of mixing. To attain this object the various types of centrifugal mixers, such as the Herbert centrifugal mixer, shown in Fig. 1, have found favour amongst foundrymen in general.

The Tempering of Sands.

To a less extent are used sand cutters, mechanical riddles and paddle mixers, but these find particular rather than general application. Whatever the type of apparatus used, however, in addition to the thorough mixing of all the ingredients, new sand, used floor sand, coal dust, and manure, chaff or any other materials, it is very necessary to temper the mix evenly, and one of the easiest and best ways of adding the tempering agent is by means of a spray.

Unequal distribution of moisture is a cause of weakness in a mould every part of which should be equally strong to resist casting strains; in the cope especially, when it supports large hanging bodies of sand. Wet spots also do not permit the

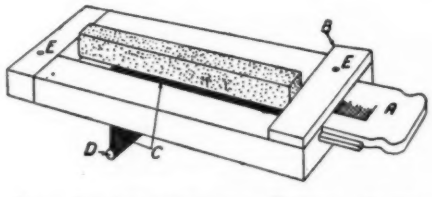

FIG. 3.—APPARATUS FOR TESTING GREEN BOND STRENGTH.

passage of gases evolved during casting, and, as is well known, are a fruitful cause of scabs and blowholes. Thus it will be seen that the manner of addition and quantity of moisture in the sand mixture are most important. As small a quantity of water as possible to obtain the desired cohesion should be used. All types of sand do not require the same amount of moisture to develop maximum cohesiveness, and the correct amount to develop the full bonding power of the clay in the particular sand in use is of importance.

The results of tests on three different types of red sands, considered from the point of view of altering the moisture content, indicated that the maximum figure is much less than each sand could absorb without losing its shape. This is shown graphically in Fig. 2 and the apparatus used in Fig. 3.

When one considers the number of different ingredients, all interdependent, forming a sand mixture, any one of which, without care in addition, is a possible cause of trouble, and the various mixtures that a progressive foundry requires, it will be seen that adequate supervision with frequent check tests is necessary in the sand-mixing department. The preparation of the various mixtures is not an inexperienced labourer's job. He cannot be expected to realise the importance of his work and its relation to the finished product.

Take for example the addition of used floor sand to the mixture. This sand should be reasonably free from shot metal, excessive coal dust, core or burnt sand, but often the mixture is made up, day after day, in the same proportions, with no regard for the continual weakening, until the trouble is forcibly brought to notice by an increasing scrap bill, of scabbed castings, drops in the mould, and excessive patching and nailing by the moulder.

Again, to the other extreme, excess of bond obtained by the use of too much new sand results in increased fettling costs and waste of new material, although it is admitted that in these days of rigid economy this is less likely to occur than the former trouble. Maintaining uniform conditions from day to day is the sole means of producing first-grade work with minimum loss. Thus it will be seen that a check on daily mixtures, or on new sand, by a simple test such as the dropping test, is of distinct value. If at first the test does not produce startling results, it must not be condemned. The greater the number of results intelligently studied, the more value the test becomes.

Sharp Sand and Binders.

Although the use of sharp sand and artificial binders has been in existence for some time, conflicting results, obtained by the use of the various binders, has caused mistrust, due to their possibilities and peculiarities not being properly appreciated.

The class of sand used for this type of work differs from those described previously, as it contains very little or no natural bond, and consists mainly of pure silica grains of fairly uniform size.

It is not generally recognised that the aim should be to use a minimum quantity of binder, and unless the grade of sand is uniform, clean, and the grains rounded, not only will an excess of binder be necessary, but the permeability of the core will suffer. Shore sand, river sand, and pit sand form the available material. River and pit sand are liable to inclusions of earthy matter, and usually

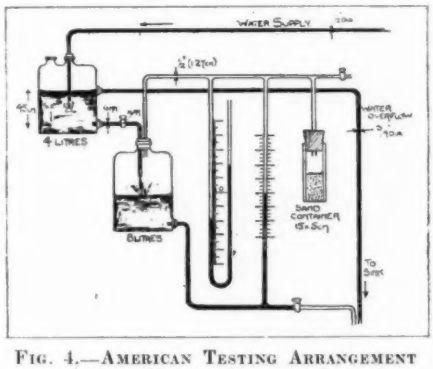

FIG. 4.—AMERICAN TESTING ARRANGEMENT FOR THE PERMEABILITY OF SANDS.

have a slight clay bond, which must be neutralised by, since it will not combine with, an excess of the binder.

Dune sand, although actually sea sand, is better than ordinary sea sand, the action of the winds tending to round and grade the sand, and to separate some of the shell, which is detrimental when in large quantities. The decomposition of the shell under the heat of the molten metal, forming carbon dioxide, together with the gas from the excess binder necessary to give strength, overtaxes the porosity of the core and results in the formation of gas holes. Sea sand also contains particles of salt in no small degree, and the decomposition of this substance during drying causes cracks to appear, distorting the finished core.

The number of different binders which have made their appearance within the present century is legion. Often a binder is sold without any attempt on the seller's part to assist the foundryman to obtain the best results from the binder in question. Practically every binder on the market can be classed under one of three headings:—(1) Oil binders; (2) water soluble; and (3) dry binders.

This classification is admittedly crude, but it is sufficient to designate the various types.

The oil binders comprise linseed, resin and other vegetable oils, and some fish oils.

The chief characteristic of the vegetable oils is their power to "dry" or assume a gelatinous form under the action of oxygen. This power is exhibited in a lesser degree in the fish oils, but practically non-existent in mineral oils; hence the inability to use these as binders. The main

examples of the dry binders are resin and pitch and similar substances, which bind by simply melting and flowing between the grains. Cement has also been tried, but its use is not recommended.

Resin has a low melting point, and at 300 deg. C. forms pitch and a gas, most of which passes up the vent. Owing to this property, resin is of most use for coremaking for high-contraction metals of moderate melting point. The water-soluble binders are by far the largest class, and comprise molasses, treacle, flour, glues and the waste products from the paper industry, sulphite lyes and chemical compounds such as silicate of soda. The binding action of this class differs from that of oils. In this case, gums are formed upon evaporation of the water content, which set hard under the action of heat during drying, and, if exposed for sufficient length of time, char to a carbonaceous residue.

It is important to note that the change from the hardened gum to the charred mass is much more sudden in the case of water-soluble binders than with oils, in which the oxidised oil film is also charred. It therefore follows that the range of drying with the former binder must be given closer attention. One of the chief disadvantages of water-soluble binders is their tendency to absorb moisture if left in damp places. With this class of binder, drying of the sand prior to the admixture of the binder is more essential than with oils.

Emulsification of oils, undoubtedly an aid to rapid and thorough mixing, is by no means absolutely necessary, and where means of drying the

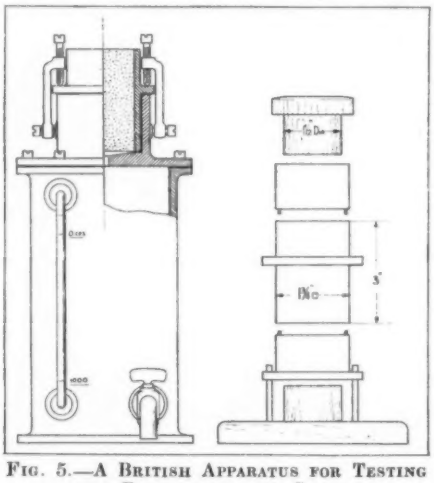

FIG. 5.—A BRITISH APPARATUS FOR TESTING THE PERMEABILITY OF SANDS.

sand are not readily available, no trouble should be experienced if the mixing of the sand and oil is carefully controlled.

Oil Sand-Mixers.

A much better result is obtained by mixing in the correct amount of moisture, and this can only be done accurately by first drying the sand. It is not proposed to discuss the various types of oil sand-mixers on the market. Foundry technical journals have descriptions and illustrations of them, but many fall far short of producing the ideal mixture; one in which maximum cohesion is obtained with minimum quantity of binder and without detriment to the venting properties. This can only be accomplished in a machine that, by a pressing and rolling action, spreads the binder evenly and thinly over the sand grains.

The requirements of different foundries make it difficult to lay down a series of tests that would be of use to all of them, but there are one or two that everyone has in common. Usually the moulder takes a handful of sand and judges by feel and fracture, but as every moulder has his own ideas as to what is correct, it frequently happens that, when less obvious wasters occur, the sand is left out of consideration.

Apart from analysis and the dropping test previously mentioned, the only other tests worth considering in a practical way and which, although affording a great deal of information, do not occupy much time, are those of the transverse test on a dried core and permeability.

Transverse and Permeability Testing of Sand.

The transverse test finally adopted by the author after many experiments with tensile and compression tests, is carried out on a carefully-rammed core 1 in. sq. by 9 in. long, tested between 8-in. centres. Although criticised by many on account of its size, it has been found to give over a lengthy period very consistent results, and gives all the information on strength necessary when using sand in the dried state.

At the American Foundrymen's Convention of this year the committee on moulding sand research put forward a standard apparatus for the permeability test. It must be understood that permeability is distinct from porosity. By porosity is meant the volume of air space between the grains, and depends on size, shape and quality, *i.e.*, proportion of quartz to clay of the grains, moisture content and density of ramming. This is relatively unimportant compared with permeability, by which is understood the property of the sand readily to permit the passage of gas through the connected pore spaces.

The construction of this apparatus (Fig. 4) makes it a laboratory instrument, and, although testing is usually looked upon as laboratory work, for those foundries unable to maintain a department of this kind, some more substantial appliance is required. A British instrument has been designed to withstand rough usage, and has given reliable results on consecutive tests, which, it should be emphasised, is the essential factor with any test. This is illustrated in Fig. 5.

Although a systematic investigation would reveal data sufficient to offer standard results required for various classes of work, it would necessitate much time and experiment. On the other hand, the information could be collected and expanded by a group, or even foundrymen in general, and the ultimate result would be more complete in addition to its much easier application due to the groundwork being more thoroughly understood.

Available methods of testing are admittedly open to improvement, but it will be only by co-operation and fair trial to all reasonable new or improved methods that foundrymen can hope to accumulate the very necessary inside knowledge on this subject of sands.

In conclusion, the author wishes to acknowledge his indebtedness to Messrs. Alfred Herbert for some of the slides, and to Mr. E. H. Broughall for the facilities offered to enable him to prepare this Paper.

Obituary.

MR. C. S. BLYTH, a director of Blyth & Pawsey, Limited, ironfounders, Rayne, Braintree, died recently.

MR. H. MOSS, brassfounder, of 201, Great Bridge Street, West Bromwich, died on November 16, aged sixty-nine.

MR. R. E. DIXON, chairman of S. Dixon & Son, Limited, brass founders, of Swinegate, Leeds, died recently, aged 51.

MR. A. BEEVER, a director of the Rotherham Steel Strip Company, Limited, died under tragic circumstances on November 17.

MR. NICHOLAS KILBURN, of Bishop Auckland, head of the engineering firm of Lingford, Gardiner & Company, Limited, died recently.

MR. W. H. HARDY, head of the Middlesbrough tube manufacturing firm of Crewdson, Hardy & Company, Limited, died at his residence, Grove Hill, Middlesbrough, on December 4. Mr. Hardy, who was 85 years of age, was at business at the works on the previous day.

MR. J. MARNEY, of 45, Burngreave Road, Sheffield, died last week. Mr. Marney, who was the proprietor of the firm of Parker & Marney, engineers and machine merchants, 8, Savile Street, Sheffield, was well known in industrial and commercial circles in Sheffield.

MR. SAMUEL JAMES BURRELL PRIOR, who has died at the age of 77, at his residence, The Hermitage, St. Leonards-on-Sea, was for many years prominently connected with the tinplate trade, and for quite half a century he was a well-known merchant till his business was taken over by Richard Thomas & Company, Limited.

The Briquetting and Use of Cast-Iron Borings and Turnings.*

By J. Alex. Gardner, M.I.Brit.F.

At a recent meeting of the Scottish Branch of the Institute of British Foundrymen, the utilisation of cast-iron borings and turnings was discussed. It was very interesting for the author, because at that time he was actively engaged upon a scheme to achieve the profitable use of

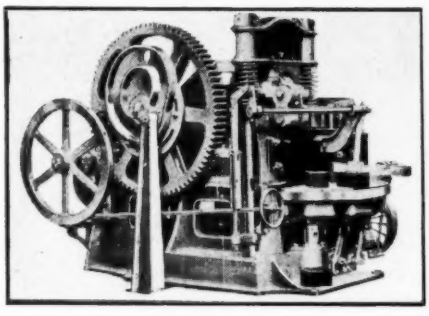

FIG. 1.—A BRIQUETTING MACHINE FOR BORINGS AND TURNINGS.

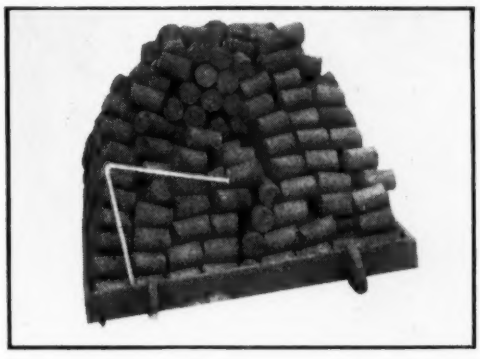

FIG. 2.—CAST-IRON BRIQUETTES MADE FROM BORINGS AND BONDED WITH CLAY WASH.

what might be classified as a more or less valueless by-product of engineering shops. Usually a very small price was obtained for cast-iron borings and turnings on the scrap market; sometimes they were almost altogether valueless, and to a round about the works, there to rust and bond together, thus forming a means of more or less permanently filling-up puddle-holes, is disconcerting. The problems pertaining to foundry practice seem never-ending. Foundrymen apparently often have everything nicely arranged and systematised, when an important casting is scabbed, another is badly drawn, a third full of slag on the top side of a flange, a fourth has

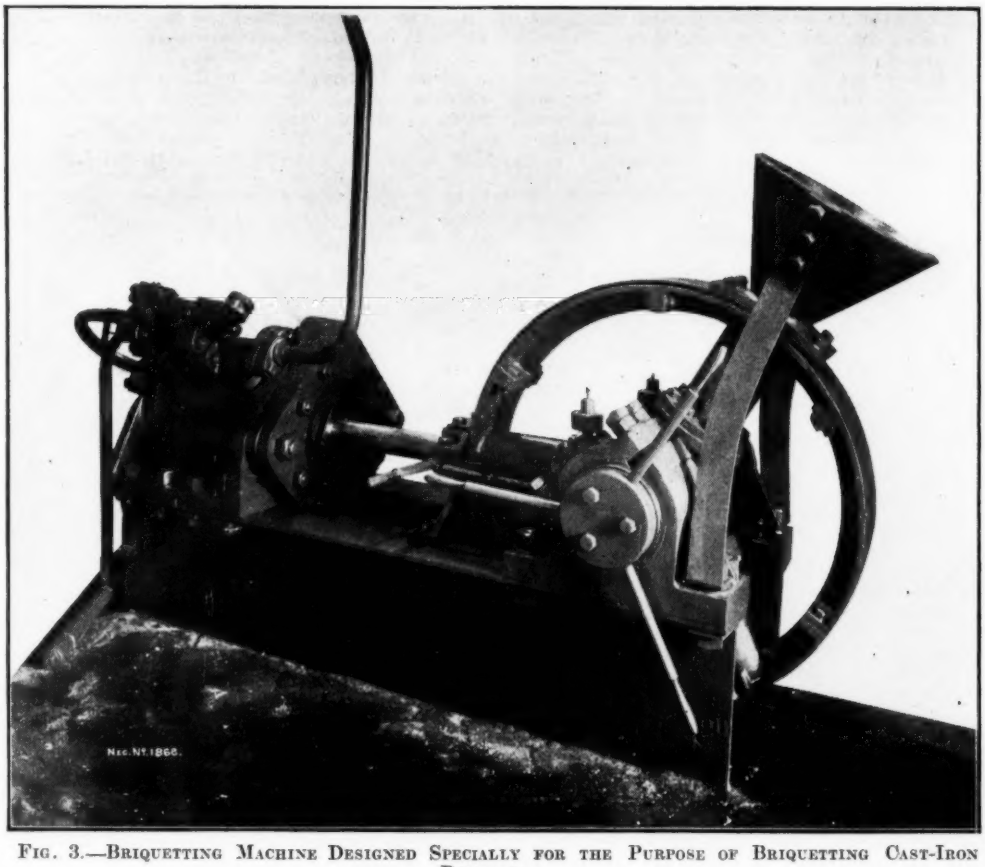

FIG. 3.—BRIQUETTING MACHINE DESIGNED SPECIALLY FOR THE PURPOSE OF BRIQUETTING CAST-IRON BORINGS.

foundryman who has the commercial welfare of his profession really at heart, the sight of these borings and turnings being carted away, often to the dump heap, or to spread on the footpaths cracked before the core irons can be slackened. In the meantime the cupola has scaffolded, and seldom if ever do they get just one trouble at a time. It may be thought that this is an exaggeration, but such occurrences do happen.

Again, the machine shop staff take a true

* A Paper presented to the Scottish Branch of the Institute of British Foundrymen, Mr. A. Lawrie presiding.

delight in commiserating with foundrymen on their misfortunes, whilst eulogising the quality of the castings turned out by our great-grandfathers. They are, however, silent when the castings are good. Meetings of the Institute of British Foundrymen never develop into mutual self admiration societies, but always have a spirit of kindly rivalry tempered with helpful camaradie.

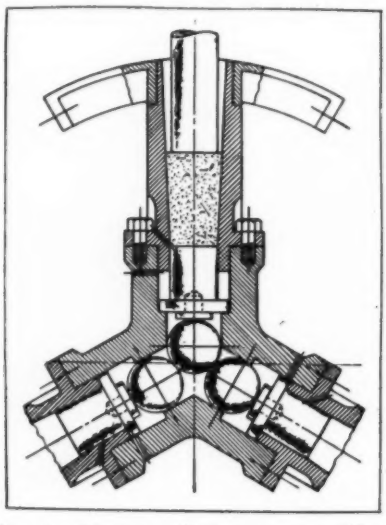

FIG. 4.—SECTIONAL ELEVATION OF THE BALL SYSTEM, WHICH EJECTS THE BRIQUETTES ON ROTATION AND DURING THE SQUEEZING OF ANOTHER.

In this spirit, then, the author presents the particulars of what has been accomplished within his own purview concerning the briquetting and useful melting of cast-iron borings and turnings. This Paper is more or less a résumé of the evolution from a simple thought on the subject matter up to its successful practice, and it is not considered to be the last word on the subject, but it is a successful established and paying proposition.

Clay Bonding is Used.

Starting from this point experiments were conducted on the lines of compressing the borings and turnings in taper tubes with a bond, finally getting a good briquette 3.5 ins. dia. at the broad end and 3.25 ins. at the narrow end, with an overall length of 6.5 ins. The briquettes thus formed could be handled quite well, and were transported to drying stoves. After being dried, a briquette could be dropped from a height of about 20 ft. on to hard material, and may possibly break into two pieces, sometimes more, but it did not disintegrate. This briquette was obtained by filling a taper tube 13.5 ins. long, the lower length of 6½ ins. conforming to the dimensions of the finished briquette. This tube was firmly packed by hand with the borings and turnings mixed with a sufficiency of clay water, the clay water being the consistency of thick cream, and the quantity of it adjusted until very little of it is squeezed out by the ramming process.

The ramming process consisted of applying about 35 tons to the mass contained in the taper tube, by means of a ram 3 ins. dia., the other end being effectively closed against the squeezing out of the borings, but not against the surplus clay water. The briquettes thus formed were in this case dried on the floor around the carriages of the stoves used for drying our loam and dry-sand moulds, thus involving no additional outlay for this part of the process. A simple semi-automatic machine was then designed, which could effect the manufacture of these briquettes. In the meantime, 15 cwts. of mixed turnings and borings were made into 213 briquettes (Fig. 2), and the resultant weight then was 15 cwts. 3 qrs. 9.5 lbs., so that the added clay weighed 93.5 lbs., or 6.3 per cent. of the whole, and the average weight of the briquettes was therefore 8.25 lbs.

Melting Results.

These briquettes were melted in a small cupola, with a 12-in. water-pressure air-blast, and cast into pigs, the yield being 13 cwts 1 qr. 10 lbs., or a loss of 1 cwt. 2 qrs. 18 lbs., or 11.1 per cent. The borings, as usual, contained much dirt from the floors.

An average sample of the borings before briquetting showed an analysis of:—2.187 Si; 0.062 S; 0.682 P; 0.528 Mn; 0.400 CC; and 2.88 Gr per cent., and after melting the pigs showed an analysis of:—1.305 Si; 0.193 S; 0.716 P; 0.171 Mn; 2.115 CC; and 0.560 Gr per cent.

FIG. 5.—A HYDRAULIC CYLINDER CAST FROM CAST-IRON BORINGS.

Early Attempts.

Having examined previous attempts, it was found that various schemes have been tried from time to time, such as packing in boxes made of metal or wood, bonding by means of rusting, or again bonding by means of Portland cement. The first of these schemes entails the destruction of the container long before the mass of the borings or turnings is fritted together, with their consequent ejection from the cupola by the air blast. The second is a slow process, even when accelerated by the use of ammonium chloride, and must by its nature involve excessive stocking and handling.

Briquetting machines are on the market, and are said to work very well. Working at pressures from 100 to 150 tons, with an output of 1,000 to 1,500 briquettes per hour, when working on such material as sand, coal and coke. In a typical example, Fig. 1, the pressure is applied by toggle levers driven by gearing, and the press requires 10 to 15 h.p. to work it. On inquiry it was found that the cost was about £1,250 for a new machine and £850 for a reconditioned one.

The resultant iron was white owing to what had evidently been a combination of the alumina in the clay used in briquetting with part of the silicon content of the turnings and borings, slagging off as one or more of the silicates of alumina.

Having thus obtained a reasonable return from the cupola in so far as quantity is concerned, and noting that a suitable addition of high silicon, or silky iron as it is called, would rectify matters with regard to quality, the author then concentrated upon building a machine which would turn out the briquettes at a reasonable speed. This is shown in Fig. 4, which exhibits a view of the working side of the original briquetting machine. The hopper gives direction to the borings and turnings which have already been mixed with clay water. The clay water is stored in a tank which is kept agitated and mixed by a small jet of air rising from the bottom. The succeeding cylinders are thus filled with the clay and boring mixture as

they pass under the hopper. The first cylinder having been filled, the three cylinders are rotated; the second is now filled, and the first is brought in front of the compressing ram. A pressure of about 38 tons is developed inside the hydraulic cylinder behind the ram which, allowing for frictional and other losses, will represent about 35 tons effectively applied to the borings, or about 5 tons per sq. in. of end surface of the briquette. The internal pressure on the cylinder being about 0.5 tons per sq. in. when the pressure is on.

The cylinders are locked in position during the compression period. The hydraulic supply to the

FIG. 6.—THE HEAD OF THE CASTING SHOWN IN FIG. 5 SPLIT OPEN.

machine is controlled by a "Homeyard" valve, which has given every satisfaction. The cylinders are again rotated when the third one is filled with borings, the second coming in front of ram, which when it functions, not only compresses the borings in this second cylinder, but at the same time by a system of three balls (shown in Fig. 4) acting in a wedging manner on well fitting pistons at the bottom of the cylinder, ejects the contents of the first cylinder as a formed briquette on to a suitably curved plate which slides it to the floor. Fig. 4 shows an elevation of this ball system.

The briquette thus obtained was a homogeneous mass about 6 ins. long, by about 3.5 ins. diam. at the broad end, tapering to about 3 ins. at the narrow end, and weighing, when dry, approximately 5.75 lbs.

Production Data.

A reasonable speed of production with three individuals when, as well as briquetting, they have to mix the borings and clay water together, is 940

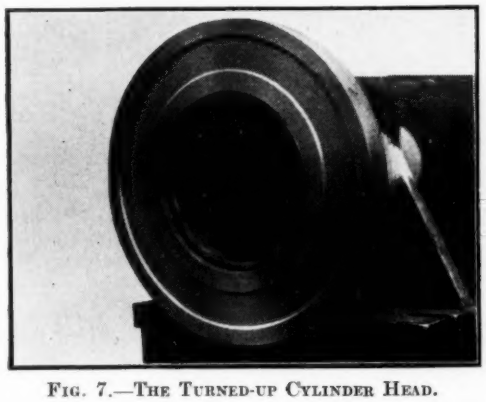

FIG. 7.—THE TURNED-UP CYLINDER HEAD.

briquettes per working day, weighing about 2 tons 16 cwts., but when the same individuals have to transport the briquettes to the drying stoves, the production runs about 760 briquettes per day, or a weight of 2 tons 5 cwts.

The greatest wear in the machine is naturally located in the tubes in which the briquettes are compressed, the taper being gradually worn parallel. However, so far there has been obtained about 64 tons, or 21,582 briquettes per tube before they are useless, which means that they do not eject properly.

As the briquettes are made, and immediately upon leaving the machine, their temperature rises about 60 deg. F. above normal, the briquettes steaming slightly. Clay water is as yet the only medium with which we get this rise in temperature under the conditions stated after compression. With all other materials tried, the press "grunts" heavily during the application of the pressure, showing heavy frictional resistance to movement of the particles of the mass past one another, with the result that, the briquette is not so homogeneous, neither can it be safely handled in transport before drying. The successful functioning of the clay water is attributed to the gelatinous nature of the hydrated oxide of aluminium, its chief content, whereby it, to a certain extent, acts as a lubricant.

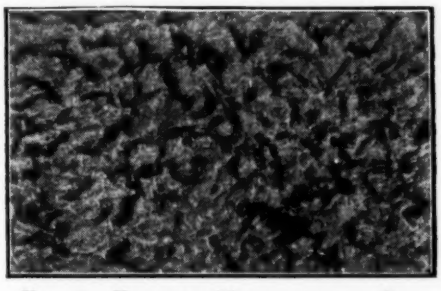

FIG. 8.—UNETCHED MICROGRAPH OF CAST IRON MADE FROM BORINGS × 80 DIAS., BUT SLIGHTLY REDUCED ON REPRODUCTION.

Drying Process.

The formed briquettes are allowed to rest some time for the purpose of primary hardening, say about 2 to 3 hours, and are then placed on the floor round about the cores, loam and dry-sand moulds in the drying stoves. The works have ample stove capacity for this purpose. After about 12 hours' heating, the briquettes are quite dry, the clay has been dehydrated, and the whole mass is found to be reasonably hard, and quite suitable to withstand the shock of falling down the barrel of the cupola during charging, that is, they may or may not break into two pieces, but they will not be disintegrated into useless powder.

The machine was operated until 827 of these briquettes had been produced, this number when dried weighed 2 tons 2 cwts. Taking the clay content at 6.5 per cent., as in the first report, it leaves 1 ton 18 cwts. of metal borings.

Details of Working.

The author divided these into three charges and placed in the cupola, 42 cwts. of briquettes, 20 cwts. of silicon iron, and 20 cwts. of good scrap,

FIG. 9.—IODINE-ETCHED MICROGRAPH OF CAST IRON MADE FROM BORINGS × 80 DIAS., BUT SLIGHTLY REDUCED ON REPRODUCTION.

adding at the same time a little more than the normal amount of coke and limestone.

The scrap used analysed:—2.400 Si; 0.040 S; 0.700 P; 0.800 Mn; 2.920 Gr; and 0.400 per cent. CC.

The high-silicon iron showed on analysis:—6.279 Si; 0.072 S; 0.375 P; 1.194 Mn; 2.380 Gr; and 0.074 per cent. CC.

Taking the borings as illustrated in Fig. 2 it is

a very difficult proposition to get a representative sample from such a very heterogeneous mass, they show:—2.187 Si; 0.062 S; 0.682 P; 0.528 Mn; 2.880 Gr; and 0.400 per cent. CC.

The cupola was operated under about 12 ins. water-pressure, and the metal came down very hot and fluid, showing that the extra coke precaution was unnecessary, but, as can be anticipated, the melt was associated with a good quantity of slag.

An analysis made from a 40 in × 2 in × 1 in. test bar, cast about the middle of the run, showed:—2.365 Si; 0.153 S; 0.667 P; 0.457 Mn; 2.040 Gr; and 0.645 per cent. CC.

Mechanical Results.

Three test bars dimensioned as above, broken on 36 in. centres gave an average load of 37 cwt. 1 qr. 2 lbs., associated with 0.432 ins. deflection.

A hydraulic cylinder was cast from with this iron It is shown in Fig. 5 after fettling, and weighs with its head 46 cwts. Fig. 6 shows this head, which weighed 19 cwts., split open revealing the grain of the metal. As will be noted, there is the usual slag and dirt right at the top, but below that, the mass of the iron is of the very finest quality, approaching the old cold-blast iron in character, which is describable as of riven oak; it is therefore significant of a high degree of solidity and toughness. Fig. 7 shows the turned flange and bore of this cylinder all significant of iron of the highest quality.

The turner reported that he was conscious of the iron being just slightly tougher than normal, but the cutting speed was not reduced in the least, and that he would rather cut this iron than the ordinary.

A test of the cuttings taken whilst boring the cylinder showed it to contain 2.281 per cent. Si and 0.075 per cent. CC.

The low figure of the combined carbon content is of course due to the much slower rate of cooling of the cylinder mass, in comparison with the test bar.

Fig. 8 shows a micro-section cut from one of the test bars polished but unetched. It reveals a very finely divided graphite content, and comparatively very little impurity. Fig. 9 shows the same section etched with iodine, and revealing the iron phosphide as white areas, with the pearlite as half-tone, and also the same small graphite plates as in No. 5. Both illustrations are under a magnification of 84 dias., and fully substantiate the analysis and results obtained from the test bars.

In the author's opinion the superior qualities of this metal are due to the mechanical elimination of graphite by the machining processes productive of the borings and turnings, and possibly also during the early melting stages, with a consequent diminution of the length and number of possible cleavage planes in the mass. In this way the product is similar to what is called "semi-steel." A daily use of briquettes, when such are available, in quantities varying from 5 to 25 per cent., have been amply proved to be productive of a corresponding increase in the strength of cast iron. They appear to function in an almost exactly similar way to steel, although perhaps in the higher percentages, steel is in the ascendant owing to its dilution of the sulphur and phosphorus content. The author has had transverse tests on a 2 in. × 1 in. bar on 36 in. centres of 46 cwts in semi-steel.

Table I shows a somewhat crude balance sheet, but it is fairly illuminative:—

Blast Control.

With regard to the 12-in. water-pressure on the tuyere box, the control is now really confined to a "fixed volume of air" method. There are so many variables associated with the functioning of a cupola, that it is felt advisable to have one fairly constant factor; so it is worked as nearly as possible to 32,000 cub. ft. of air per ton of iron. If, then, the iron is cold, it is known that more coke is required of the quality being used. If, on the other hand, the iron is hot, but the melting is slow, then too much coke is being used, and it can be controlled accordingly.

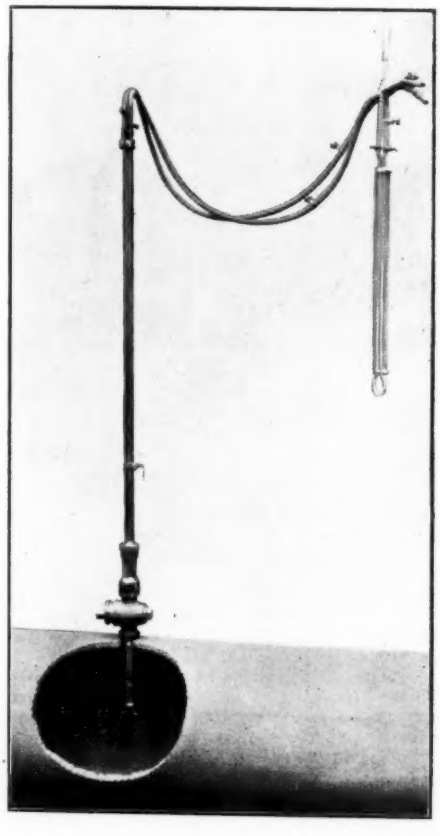

FIG. 10.—A PITOMETER TUBE USED IN CONJUNCTION WITH AN INCLINED MANOMETER FOR CUPOLA VOLUME CONTROL.

For volume control, the author is using a Pitometer tube (Fig. 10) in conjunction with an inclined manometer, one limb of which is larger in bore than the other; in this way a relatively long sensitive column of water is obtained, and a very fine adjustment of the air is possible.

It is found that a Pitot tube is inexpensive, does not materially affect flow of air, is easily fitted, takes up very little room, and is very accurate when installed as indicated. It may be of interest to give the formula for the Pitot tube calculation with reference to the flow of air in a pipe. The formula is:—

$$V = C\sqrt{2gH.}$$

Where V is the velocity in feet per sec., C is a slightly variable constant, depending upon the contour and size of the Pitot tube, but 0.865 may

TABLE I.—*Rough Balance Sheet assuming 25 tons of Briquettes, with clay content of about 7 per cent.*

Leaving say, 23 tons available iron:—

23 tons	Borings at 30/–	£34	10	0
2 „	Clay at 20/–	2	0	0
12½ „	Silky at 100/–	62	10	0
6½ „	Scrap at 90/–	28	2	3
6½ „	No. 3 Pig at 100/–	31	5	0
Hydraulic Supply at 40/–		2	0	0
Wages 1 Man at 40/–		4	5	0
„ 2 Boys at 12/–		2	12	6
		£167	4	9

A furnace loss of 11 per cent. on 50 tons leaves 44.5—say, £6 per ton for an iron of 36 cwt. Transverse Test:—

Tons. Cwts.		
44 10 at £6		£267
Cost of same		168
		£99

Taking the proposition all round, it will be noted that it is a fairly profitable one.

be taken as a good figure; g is the gravity, and H the inches of water pressure in a vertical U tube, converted into the equivalent of feet of air pressure at 15 deg. C. and 760 mm. pressure.

Incremental, vertical water-pressure-heads are calculated out by above formula, thus getting the air velocities at these heads, and under the pressure of the blast main. From these velocities in conjunction with the area of the blast main, the respective volumes are calculated, and these are again corrected from the blast-main pressure to that of the normal atmosphere or 760 mm.

A curve is then plotted from the foregoing data, and from this curve, equal incremental volumes are noted with reference to the respective heads of water. From these figures a sloping manometer with a wide and narrow tube is calibrated, giving a very sensitive and accurate instrument.

Conclusion.

In conclusion, the author expresses his thanks to Mr. Kennedy, managing director of Messrs. Clenfield & Kennedy, Limited, Kilmarnock, for permission to read this Paper. His thanks are also due to Mr. Robert M. Robertson, the plant draughtsman, for humouring his vagaries in machine design, and most materially assisting in many ways. Lastly, he thanks Mr. William Wyllie, one of the Institute members, who is to him a never-failing friend in times of trouble.

Prof. Bauer Answers His Critics.

We have received from Professor O. Bauer a letter answering the criticisms of his article of "Pearlitic Cast Iron" which appeared in our issue of June 7. Translated, his letter reads as follows:—

SIR,—Allow me at the outset to thank you for the kind comment you made in your issue No. 355 when reproducing my article on "Pearlitic Cast Iron."

I should like to state with reference to the remarks made by speakers in the correspondence which followed, as far as I can judge, they have not caught the real extent of my communication. The centre of gravity of my article was that I intended to show that it was possible by the "pearlitic-casting process," described by me, to produce a grey iron on solidification from a pig-iron low in carbon, phosphorus and silicon; which, under ordinary circumstances, would solidify white, and that at the same time, due to the low total carbon content, a microstructure is produced which consists of a pearlitic matrix with enclosures of fine graphite. Such a microstructure pre-supposes, as proved not only by my own experiments but also by those made earlier by numerous other investigators, properties of strength, which exceed considerably those possessed by the usual kinds of cast iron. With the normal methods of casting, however, it has not been possible hitherto to produce with any certainty the all-pearlitic-graphite structure, which was more or less a matter of chance.

The remarks by contributors to the correspondence about the influence of sulphur were of interest to me, but contained nothing new. The fact has been known for a fairly long time that a higher sulphur content even with a small quantity of manganese present had no great influence on the strength properties of cast iron, but on the other hand it had an adverse influence on the purely foundry-technical properties of the iron as, for instance, contraction, piping, gas-production.

I used a foundry iron high in sulphur with the express intention of showing that even a higher sulphur content had no adverse influence on the strength of pearlite cast iron. Finally, I should like to remark that there are no difficulties in the way of casting pearlitic iron from the cupola provided the materials for the charge are properly selected, and—before all—provided that especially as regards the rate of cooling, the casting process is carried out in conformity with the provisions of the patent specification.—Yours, etc.,

(Prof. Dr.) O. BAUER.

Company News.

Consett Iron Company, Limited.—Interim dividend, 6d. per share on ordinary.

Fabric Machinery, Limited, Lancaster Street, Neepsend, Sheffield.—Capital £100 in £1 shares.

Davy Brothers, Limited.—Interim dividend, 2½ per cent., less tax, on ordinary and preference shares.

Abingdon Works, Limited.—Net loss, £3,503; brought forward, £3,982; difference, £479, carried forward.

Power-Gas Corporation, Limited.—Profit, £14,197; brought forward, £10,858; reserve, £2,000; dividend, 4 per cent., less tax; carry forward, £11,070.

Excelsior Metal Company, Limited, 177, Fleet Street, London, E.C.4.—Capital £1,500 in £1 shares. Directors: B. Jones, J. R. Williams and A. J. Cameron.

Empress Coppersmiths and Engineers, Limited, Empress Street, Cornbrook, Manchester.—Capital £2,500 in £1 shares. Directors: R. L. Gregson and W. Laworth.

Caterham Works, Limited, 181, Queen Victoria Street, London, E.C.—Capital £11,000 in £1 shares (1,000 deferred and 10,000 ordinary). Manufacturers and merchants, etc.

International Hydro-Electric Development Syndicate, Limited, 3, Broad Street Buildings, Liverpool Street, London, E.C.—Capital £10,000 in £1 shares. Secretary: A. W. Derring.

Dorman, Long & Company, Limited.—No dividend on ordinary for half-year to September 30. Dividend on preference and preferred ordinary for half-year will be paid on December 31.

Richard Hill & Company, Limited.—Net profits, £5,266; brought forward, £6,203; final dividend, 3 per cent. on preference shares, making 6 per cent. for year; carry forward, £6,069.

Edgar Windsor Richards & Company, Limited, 10, Long Acre, London, W.C.2.—Capital £2,000 in £1 shares. Consulting engineers. Directors: E. J. W. Richards and T. H. Oswald.

John I. Thornycroft & Company, Limited.—Profit, £8,753; brought forward, £60,759; no distribution on ordinary shares; preference dividend, 6 per cent., and 5 per cent. on participating preferred ordinary; carried forward, £45,132.

B. J. G. Street & Company, Limited, 75, Eldon Place, Vauxhall Road, Liverpool. Capital £3,000. Iron, steel and metal merchants, etc. Directors: H. Bickersteth, C. H. Bickersteth and B. J. G. Street (managing director).

Berry & Kennedy Metals, Limited, 110, Cannon Street, London, E.C.—Capital £25,000 in 20,000 £1 7 per cent. cumulative preference and 20,000 5s. ordinary shares. Managing directors: E. W. Berry and W. B. Kennedy (both permanent).

Utrecht Steel Works.—The report of the Nederlandsche Staalfabrieken (late J. M. de Muinck Keizer), of Utrecht, states that slackness in trade and low prices characterised the financial year 1922-23. As a result of the competition of countries with a depreciated currency it was not always possible for the Company to cover costs of production fully when fixing sale prices. Under these circumstances it was only possible to earn gross profits of an amount much below the sum proposed for depreciation. The mill rolling small sections was in operation during the whole of the year, mostly on day shift, although for a short time both day and night shifts were worked. The electric furnace was also in service the whole of the year, working chiefly for the steel foundry. As a consequence of the advance in the market prices for rolled products at the beginning of 1923, due to the occupation of the Ruhr, it was possible to work the open-hearth furnaces and the cogging mill at full capacity. The billets produced were principally for export. So far the new financial year shows no improvement. The accounts show gross working profits amounting to 64,000 florins (£5,340), as compared with a loss of 91,000 fl. (about £7,583) on working in 1921-22. After allotting 257,000 fl. to depreciation, the final result is a loss of 222,000 fl., as against a loss of 68,000 fl. in the previous year, when the reserve funds were drawn upon to the amount of 230,000 fl.

Contracts Open.

Hayes, Middlesex, December 17.—Provision and construction of a sewage ejector station, including two 50-gallon pneumatic ejectors, cast-iron tubbing and short lengths of rising and air mains, for the Hayes Urban District Council. Mr. D. C. Fidler, engineer and surveyor, Council Offices, Hayes.

Sydney, N.S.W., December 14.—Two direct-coupled steam-driven centrifugal pumps, for the Metropolitan Board of Water Supply and Sewerage. The Department of Overseas Trade (Room 50).

XUM

An Apprenticeship Course in Foundry Practice.—LXVII.

By Ben Shaw and James Edgar.

ALUMINIUM CASTINGS.

Aluminium, although referred to as the most abundant metal in the earth, was first produced in an almost pure form as recently as 1854, but it is only during more recent years that its value has been freely recognised. Its lightness, compared with other commercial metals, increases its value for many purposes. It possesses reasonable strength when suitably alloyed, and it is both malleable and ductile. It can be rolled into thin sheets or into wire. It melts readily at a temperature of 658 deg. C., and, as it is very fluid when molten, it is capable of being made into very thin and intricate castings. Although aluminium castings are used for many purposes, they are in greater demand for motor-car work and, to a considerable extent, for aeronautical work in which the lightness of the metal is of primary importance.

The increasing demand for aluminium castings is gradually favouring the necessity for specialisation in their production and although, where the production is small, these castings are being made as part of the work in the brass foundry, it is becoming recognised that the separate foundry for dealing with aluminium facilitates concentration on the production of sound castings. Just as there are variations in moulds for iron and steel, there are characteristic differences between those for brass and aluminium, and by specialising, the difficulties encountered are more easily overcome. When moulders are called upon to prepare moulds alternately for brass and aluminium, they neither do themselves nor the firm justice, owing to the difference in the density of the moulds. Quite apart from the making of moulds, the presence of aluminium in the brass foundry is likely to contaminate brass and bronze mixtures and cause porous castings. It is therefore better that aluminium castings should be made in a separate foundry, though it may be an adjunct of the brass foundry.

Aluminium Mixtures.

Aluminium, in its pure form, is low in tensile strength, is comparatively soft, and is easily burnt in the melting. For these reasons it is invariably cast as an alloy, but these alloys, and more especially those having a high aluminium content, are all somewhat loosely termed aluminium. With the exception of lead and antimony, aluminium alloys readily combine with other metals. Zinc and copper are most generally used. Zinc considerably increases its strength, while copper hardens without increasing its strength perceptibly. A combination of both these metals alloyed with aluminium is very serviceable for castings, thus a commonly-used composition for ordinary work consists of 88 per cent. aluminium, 9 per cent. zinc, and 3 per cent. copper. Tin is sometimes introduced at the expense of zinc for motor-car castings, the alloy consisting of 87 per cent. aluminium, 8 per cent. copper, and 5 per cent. tin. This alloy is more costly and more difficult to cast soundly. Magnesium and manganese are alloyed with aluminium as in the case of the special aluminium alloys, magnalium and duralumin. The composition of these alloys varies somewhat, thus magnalium may contain up to 10 per cent. magnesium, the remainder being aluminium, while duralumin contains 0.5 per cent. magnesium and 0.5 per cent. manganese, the remainder consisting of various proportions of aluminium and copper, the aluminium content being over 90 per cent. Tungsten, nickel, iron and chromium are also alloyed with aluminium for special purposes, as in the case of the alloys, romanium, which contains tungsten and nickel, wolframium, which contains tungsten, magnalium, which invariably contains iron as well as manganese, and chromaluminium, which contains chromium. Each of these special alloys contains other metals, such as copper, zinc or tin, besides those specially referred to. An alloy frequently used for first-quality castings in connection with aircraft work is known as L5 aluminium alloys. The specification demands that the composition of the castings should have not less than 12.5 per cent. of zinc or more than 14.5 per cent., copper content not less than 2.5 per cent. or more than 3 per cent., lead content not to exceed 0.1 per cent., silicon not to exceed 1.0 per cent. and iron not to exceed 1.0 per cent., the remainder consisting of aluminium. In making up this mixture it is necessary that the copper should at least be of 99.3 per cent. purity, and it is stipulated that the zinc used must be best quality. Test pieces are required to give a tensile strength of 12 tons per sq. in., and an elongation of 4 per cent. on 2 in.

Melting Practice.

In many foundries prepared aluminium alloys of known composition are used, particular brands being obtained from firms who specialise in aluminium and its alloys, such as the British Aluminium Company, Limited. In others the alloys are made up in the foundry. In both cases, however, a certain amount of mixing is usually done with a view to producing castings for specific purposes varying in conditions of service. When the aluminium content is high it should be melted first and the alloying metals added gradually and in small pieces. It is very important that the temperature should be as low as possible. The melting temperature of aluminium is about 660 deg. C., and the melting point of the general alloys used vary little from this temperature. This metal has a great affinity for oxygen forming aluminium oxide, and, although it is frequently cast without using a flux, it is profitable to use some suitable flux in order to reduce the percentage of loss. For this purpose sal ammoniac (NH_4Cl) is probably the best and should be added to the metal after melting and before the crucible is lifted from the furnace. A mixture of common salt (NaCl) and fluor-spar (CaF_2) is sometimes used, but this is likely to injure the metal by attacking the walls of the crucible and introducing infusible compounds. Another flux sometimes used is zinc chloride (ZnCl), which is effective enough but requires considerable care. This flux, when in a solid state, takes up moisture from the atmosphere when allowed to stand, and if allowed to stand sufficiently long will resemble syrup. It is the moisture that is a nuisance, but if mixed with sawdust it can be used as a surface flux, but this does not affect the oxide suspended in the metal. It must be remembered, however, that aluminium is a particularly active metal, and through some effects it can submerge zinc chloride in the fluid metal, and it is not advisable to attempt such a course, otherwise the result may be very disastrous. This flux should be used very sparingly indeed and is not recommended. Charcoal, too, is sometimes used for the purpose of absorbing oxygen, but the difficulty of contaminating the aluminium arises. The aluminium will absorb carbon forming a carbide which not only affects the appearance of the castings but also their strength. In ordinary melting practice a small amount of carbide is usually formed, but it is not wise to assist its formation by using charcoal as a flux. Sal ammoniac is a more suitable flux for the purpose because it is easily used and is effective.

The furnaces used for melting the alloys of aluminium are similar to those used for brass, the pit type of furnace installed in a battery being one in common use when the work is associated with the brass foundry, but when separated some form of tilting or stationary lift-out furnace is invariably used. Coke is commonly used as fuel, although both oil and gas have much to recommend them for the purpose, as there is better heat control and they are cleaner.

Preparation of Moulds.

Moulds for aluminium are invariably made in green sand, and in many instances the cores, too, are green. This is largely due to the fact that the alloys of this metal are very hot—short and contract considerably necessitating the use of a weak mould. Castings made in green sand are produced more economically than in dry sand, which is an important consideration. The preparation of moulds does not vary from the practice prevailing for brass, excepting in minor details, which are nevertheless important. It is important, for instance, that the moulds should not resist the shrinkage and contraction of the metal to such an extent as to cause undue strain to the casting. The sand needs to be more lightly rammed than for similar castings in brass, so that it will more readily collapse under slight pressure. Copes should be well vented in order to relieve the pressure from the metal as it rises in the mould, and this is frequently necessary because of the comparatively low head pressure exerted by the metal. Sands that are suitable for brass are effectively used for aluminium, and it is not necessary as a rule to provide special facing sands. A fine-grained sand is desirable to give the castings a good surface. French chalk dusted over the surface of the mould and sleeked imparts a very smooth skin to the casting, and is used when a good surface is specially desirable. The area of gates for aluminium compares with that necessary for brass, ample gating being advisable, and metals should be admitted to the bottom of the mould with as little agitation as possible. This is desirable, because a thin film of oxide is formed on the surface of the metal which, when subject to violent disturbance, not only increases in quantity, but becomes associated with the metal when it solidifies and materially affects the strength. Dross in aluminium does not readily rise to the surface, and therefore is more easily entangled in the metal than the dross of much heavier metals. If poured at the bottom of a mould, the oxide skin will rise with the metal affording a protection against the formation of more oxide and, although the ordinary green-sand mould should be filled quickly, the runners should be distributed so that the metal enters as quietly as possible. In the majority of aluminium castings, soundness is only obtained by the use of chills. Some prefer to make use of risers, and while they are effective in many instances, it is not always possible to reduce the drawing in the vicinity of parts having a heavier section by such means. Chills are more satisfactory in practice. The object of their use is to extract the heat from thicker parts of the casting in order that the rate of cooling will be more regular, thus preventing drawing or cracking to which aluminium castings are especially subject. Cast iron, copper or aluminium chills are used for the purpose, and they should be made to conform to the shape of the mould of which they form a part. Cores for moulds to receive aluminium need to be just strong enough to hold so that they will more readily crush under the strain of the metal. When green-sand cores are used, as is frequently desirable, when they form external shapes that have been blocked out in the pattern for convenience in moulding—a method sometimes adopted in work of a repetition character—a very lightly bonded sand is used. The same applies to the sand for cores that are to be dried. Greater strength is of course necessary, but the percentage of bond should be low. An artificial bond is desirable because of easier control in giving the requisite strength, but more particularly because a bond can be used which is more or less carbonised by the heat of the metal, and the core consequently becomes weak and readily collapses under slight pressure. Some foundries prefer a bond which, on baking, forms a hard skin on the core but possesses a very weak interior. The outer skin is disintegrated when casting and the whole core becomes loose and does not strain the metal. Further, the castings are readily cleaned. Others prefer a bond which softens with the heat of the metal but is not affected until the shape has been defined. This form of bonded core offers little resistance to the changing form of the casting, but invariably aluminium castings are either eased from their moulds or shaken out while they are hot. Resin is frequently used as a bond, but ordinary core gum gives satisfactory results.

Owing to the alloys of aluminium being comparatively light many moulds are cast without being weighted down or clamped. In such cases the weight of the top box may be sufficient to resist the pressure tending to separate the box parts, but it is wise to err on the side of safety and, excepting on small work, some provision should be made against a lift and the subsequent run out, because it is not only head pressure that is to be resisted, but also momentum and the extent of the pressure thus exerted is not easily ascertained.

Casting Aluminium.

The temperature of the aluminium at the time of casting has undoubtedly a very important bearing on the production of sound castings. It must be remembered that this metal is very active in a fluid state, and when the temperature is high pin holes are likely to be present in the resulting casting, especially if made in green-sand moulds. This is due to the activity of the aluminium in splitting the steam generated into hydrogen and oxygen, which causes the minute holes. These not only spoil the surface of the casting but break the continuity of the structure and thus reduce its strength. To get the best results aluminium should be poured at as low a temperature as will ensure the mould being completely filled. The casting temperature must necessarily vary somewhat according to the thickness of the metal in the castings to be made, thus a temperature that would give good results for very thin sectional work would be too high for castings that are thick, because the fluidity of the metal would be preserved longer and gases are more likely to be absorbed. The surface of castings that are made when the temperature of the metal is too high is invariably discoloured, and this discoloration is also noticeable near the runners on castings that are thin. The average temperature of aluminium alloys is near to 660 deg. C., though a slight variation must be made to suit the particular alloy and to ensure the complete filling of the mould. A pyrometer is an advantage in determining the temperature, and is better than depending upon the sight of the metal, however skilful the operator may be. When the temperature of the metal is too high, scrap can be introduced or it may be allowed to stand until the temperature is suitable for casting without injurious effects.

Personal.

MR. C. DOUGLAS TERRY has joined the staff of Herbert Terry & Sons, Limited, spring manufacturers, of Redditch. He is the son of Mr. A. E. Terry, a director of the company.

MR. R. P. FISHER, who for a period of 44 years has filled the position of manager of the Moorhead branch of Newton, Chambers & Company, Limited, of Thorncliffe, is retiring into private life.

MR. W. H. LE GRAND CHAMBERS, J.P., a director of S. Instone & Company, Limited, also of the Askern Coal & Iron Company, Limited, and managing director of the Bedwas Navigation Colliery Company (1921), Limited, has joined the boards of the Askern Washery Coke & By-Products Company, Limited, and the Askern Garden City Association, Limited.

MR. J. SHERWOOD, of Gainsborough, manager of the moulding shop of Marshall, Sons & Company, Limited, Britannia Ironworks, recently had a remarkable escape. It appears that a crane carrying a ladle of molten metal collided with a jib crane, and the contents of the ladle were precipitated in all directions. Mr. Sherwood was extensively burned and had to be removed to hospital.

Wills.

BOSTOCK, W. H., late of Tolley, Sons & Bostock	£28,294
PERRY, G., of Portobello, Willenhall, Staffs., metal merchant	£5,430
SUMMERSCALES, J. B., for six years senior partner in W. & S. Summerscales & Sons	£40,348
DAY, A. J., head of Day, Summers, & Company, Limited, engineers and shipbuilders	£143 50/

The Founding of Admiralty Gun Metals and Allied Alloys.*

By F. W. Rowe, M.I.Brit.F.

In dealing with such a subject as this, it is neither possible nor desirable to avoid touching on brass foundry practice in general. A large portion of the matter in this Paper may be taken to apply to all brass foundry practice unless specifically excepted.

The major portion of the work of non-ferrous foundries is producing gun-metals of some kind or other. Strictly speaking, the term "gun-metal" denotes a ternary alloy of copper, tin and zinc, in which the copper is not less than 80 per cent. In the average gun-metal casting there is also an appreciable proportion of lead (added intentionally or otherwise), and it is proposed to include a consideration of these alloys also.

Simple binary copper-zinc alloys containing zinc up to 20 per cent. are not used to a very large extent for engineering castings. They are not so easy to handle as ternary alloys in the foundry and their mechanical properties do not fit them for many duties. Their appearance is not so good in the finished casting as the ternary alloy, and they are more liable to unsoundness and blowholes;

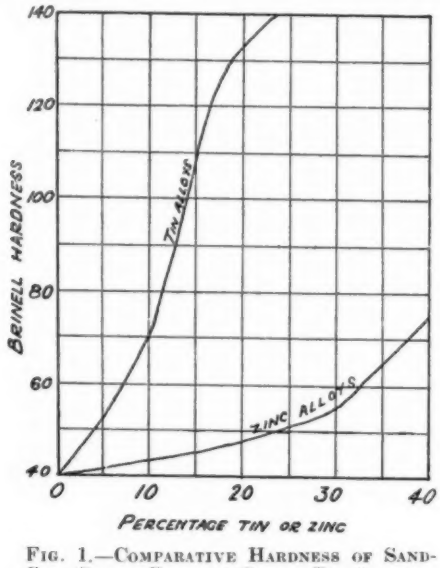

FIG. 1.—COMPARATIVE HARDNESS OF SAND-CAST COPPER ZINC AND COPPER TIN ALLOYS.

also they are too soft, that is, the yield point is low, and consequently are very easily deformed and possess very little resistance to abrasive wear. Despite these disadvantages, it is the writer's contention that there are a great many more applications for these alloys, especially with a zinc content of from 15 to 30 per cent., than is usually appreciated. The great need for reducing the world's consumption of tin in order to bring down the price to a reasonable level should render one conservative in the use of this element.

The Hardness of Bronze and Brass.

The binary copper tin alloys are fairly extensively used especially if one includes those in which phosphorus is present also. Tin has a much greater hardening effect on copper, as will be seen from Fig. 1, which shows the relative hardnesses of copper, zinc, and copper tin alloys in the commercial ranges. Moreover, apart from the general hardness figure, the constitutional difference between the brasses and the bronzes render the latter much more valuable for resisting wear.

The brasses within the range under consideration comprise a metal built up of crystals of practically uniform composition and hardness throughout, as will be seen in Fig. 2, which is a photomicrograph of a sand cast 20 per cent. zinc-copper alloy at a magnification of 100 dias. On the other hand tin bronzes with fairly large amounts of tin have a quite different structure.

Up to 7 or 8 per cent. tin in a sand-cast alloy the structure is essentially the same as a brass, *i.e.*, built up of homogeneous crystals all of the same variety, but harder than those in a copper-zinc alloy containing an equivalent amount of zinc.

Above 7 or 8 per cent. tin a new constituent makes its appearance, which is metallographically known as the beta eutectoid or complex.

This constituent varies slightly in composition in different alloys, and the point at which it makes its appearance depends on the other constituents present and the method of casting and cooling the alloy. These crystals are intensely hard, and have a hardness approximately nine times that of copper. The proportion of this constituent present varies of course with the tin content. With a simple tin bronze of about 16 per cent. tin this constituent forms about 20 per cent. of the total alloy. It is this constituent which gives the bronzes their good resistance to abrasion and their excellence as bearing metals.

Fig. 3 shows a photomicrograph at 100 dias. of a simple bronze containing 16 per cent. tin. The mottled network is the beta complex in a matter of a solid solution in copper containing about 7 per cent. tin. The Brinell hardness of this alloy in the cast state is 120, the copper-tin solid solution having a hardness of about 55, whilst pure cast copper is about 40.

Gun-Metal Alloys.

Perhaps the best known of the ternary alloys—the gun-metals—is Admiralty gun-metal consisting of 88 per cent. copper, 10 per cent. tin and 2 per cent. of zinc. The Admiralty specification fixes the minimum tin content at 10 per cent., with maximum impurities, other than zinc, of 0.5 per cent. which is generally interpreted to mean lead

The physical tests required by the Government in this country are 14 tons tensile with not less than 7 per cent. elongation.

These physical test requirements are quite low, and no founder whose supplies are normal and whose melting practice is anything approaching good should fail to meet them. A good foundry working on these bronzes will average a tensile strength slightly over 16 tons per sq. in., and an elongation of 15 per cent. It is quite possible with a modicum of care to obtain over 20 tons tensile strength with more than 20 per cent. elongation in ordinary sand-cast bars.

A foundry with which the writer has been connected averaged 16.96 tons and 17.8 per cent. elongation on 187 test bars, many of which were cast on the job or machined from the actual castings. The Brinell hardness for Admiralty gun-metal should not be less than 60 on average sections, *i.e.*, ¾ to 1½ in. thickness of metal.

Influence of Remelting.

It is often amusing to note the pride with which many brassfounders advertise the fact they use only virgin metals in the production of their gun-metals.

It is an undoubted fact that twice-melted metal gives much sounder and stronger castings than virgin metal. It is a definite rule in the foundry with which the writer is connected never to exceed one-third virgin mix in the gun-metals. Heavy scrap is much better than virgin metal provided the composition is correct. Probably the best mixing for ordinary foundries who consume their own machine-shop scrap is one-third virgin, one-third heads and runners and one-third re-melted borings. It is never safe practice to use an appreciable quantity of borings in gun-metals without first re-melting and ingotting, nor is it economical in the long run

* A Paper read before the Burnley Section of the Institute of British Foundrymen.

The ordinary 120- or 150-lb. pot is not suitable for melting borings, and the length of the heat is unduly prolonged and considerable surface oxidation of the borings takes place before they are melted. The golden rule in all brass-foundry practice is to melt rapidly and avoid oxidation.

More trouble is caused by "stewing" metal and melting under oxidising conditions than is usually appreciated. Working on the ordinary pit-fire furnace a 150-lb. pot of gun-metal should not be in the furnace longer than 1½ hours. It is no uncommon thing to find foundries taking 2½ hours to get this weight of metal down, and an infinite amount of trouble may be experienced from this cause alone, especially when working on more sensitive alloys than Admiralty metal.

Liquation Troubles.

In heavy castings of Admiralty gun-metal, trouble is sometimes experienced due to liquation of the eutectoid. That is, the eutectoid drains away from the heaviest portion of the casting, leaving it porous. Another trouble that is experienced with heavy sections is that in the slowly-cooled portions of the casting the eutectoid forms a network of fairly large masses of the metal which considerably reduces the strength of the metal and makes it very brittle. In rapidly-cooled gun-metal, the eutectoid is dispersed in fine particles, and is present in a less quantity. Both these troubles can be considerably reduced by paying proper attention to moulding and casting conditions. Green-sand moulds should be used wherever possible, and very close attention

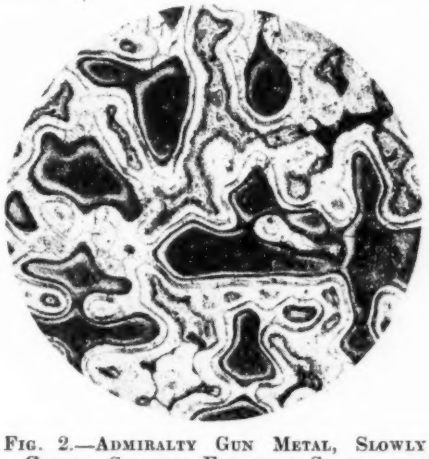

FIG. 2.—ADMIRALTY GUN METAL, SLOWLY COOLED, SHOWING EUTECTOID SEGREGATION ETCHED $(NH_4)HO + H_2O_2$, MAGNIFIED 100 DIAS.

should be paid to the temperature at which the metal is poured. The primary solidification of Admiralty gun-metal sets in at 995 deg. C. + or − 5 deg. C. The correct casting temperature varies, of course, with the section of the casting and the method of moulding, *i.e.*, green- or dry-sand. It is usual, with all alloys, for most foundrymen to err on the high side rather than the low. This is usually especially evident when a fair number of boxes have to be cast up from one pot of metal and the bogey of short runs looms high.

It may be taken as a fair average that it is impossible to cast more than eight boxes with one pot of metal and have the requisite mechanical properties in the castings in each box.

During the war it was generally noticed that those foundries which had most difficulty in meeting Government Specifications were those who were using large melting crucibles in pit-fire furnaces. It is false economy to use in this type of furnace large crucibles when the majority of work is light. By that is meant that using 200- and 250-lb. pots for work which runs 10 to 15 lbs. of metal to the box. When this is done it necessitates pouring the first box at from 1,290 to 1,330 deg. C. in order to have the metal sufficiently fluid to run the last box. The best results for light work and using ordinary pit-fire furnaces are obtained when 100- and 120-lb. crucibles are used, that is, when crucibles are used holding sufficient metal to run six or seven boxes at the most.

Casting Temperature.

The casting temperature for Admiralty gun-metal should never exceed 1,200 deg. C. for all normal work, and should preferably be lower. The writer has cast some tons of fairly small light-sectioned castings (½ in. to ⅝ in. thick) at 1,110 deg. C. to 1,140 deg. C. with excellent results. Bars cut from these castings regularly show over 19 tons tensile strength and 18 to 22 per cent. elongation.

No paper on gun-metal would be complete without some reference to the remarkable increase in ductility which accompanies the annealing of these castings. This fact was first brought into prominence by the brothers Primrose. Admiralty gun-metal castings, after annealing at 650 to 700 deg. C., often show an increase in ductility of 100 per cent. This ductility is due to the absorption of the eutectoid present—the microscopic appearance after annealing being a single solid solution.

The general hardness of the metal is not appreciably altered, but of course the metal is homogeneous, *i.e.*, it consists of crystals all of the same hardness, not as previously of small intensely hard crystals embedded in a softer matrix. This type of structure is not always desirable, especially in work to resist abrasion, and it may be safely said that bearings of parts subject to frictional wear should never be so treated. For ordinary castings annealing is of great value, and especi-

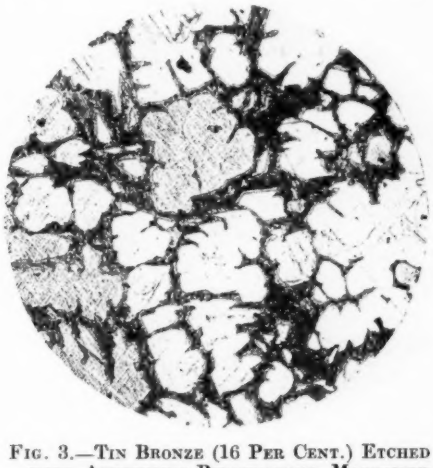

FIG. 3.—TIN BRONZE (16 PER CENT.) ETCHED WITH AMMONIUM PERSULPHATE, MAGNIFIED 100 DIAS.

ally for castings in this alloy for pressure work where trouble is experienced with porous sections. The effect of annealing is to render the metal much closer and able to stand liquid pressure without leaking.

Allied Alloys.

Although Admiralty gun-metal has been dealt with at some length owing to its important position in the engineering industry, it is the writer's opinion that the value of this alloy is considerably over-rated. The close adherence of the Government Departments to this particular alloy has led to its popularity with engineers in general, but it is more than certain that very few brass-founders would prefer to work this alloy if left with a free hand.

As a bearing metal and to resist abrasion it is undoubtedly inferior to phosphor bronze, and the same may be said regarding its resistance to corrosion.

Where these two qualities are not required the same strength and much greater ductility can be obtained with gun-metals lower in tin and higher in zinc. Alloys with a lower tin content and higher zinc are much easier to work in the foundry and less liable to liquation, segregation and porosity troubles.

Quite a noticeable improvement with regard to strength and ease of working in the foundry can be effected by reducing the tin content to 9 per cent., and increasing the zinc to 3 per cent.

The quantity of eutectoid is, of course, lessened, but the general hardness is the same as that of standard mixing. The average tensile strength is higher, and no difference is observable in the yield point. The elongation is materially improved, and the metal is more homogeneous, *i.e.*, less variation is experienced in light and heavy sections of a casting.

A very good serviceable bronze of great toughness is one containing 8.8 copper, 6.5 tin, 0.5 lead and 5 per cent. zinc, which will give 18 tons per sq. in. tensile, 8 tons yield point, 45 per cent. elongation and Brinell hardness of 60. This bronze will give better or at least as good service as the more difficult and expensive Admiralty gun-metal in all cases where no bearing surface or no resistance to corrosion is required. It should be cast at a higher heat than Admiralty gun-metal though never above 1,225 deg. C.

Gun-Metal for Pressure Work.

One of the great calls for bronze castings is for small parts to resist liquid or gaseous pressure. The composition of the alloys used for this work often vary somewhat, but all of them contain a proportion of lead. Lead is of considerable value where soundness and freedom from porosity are primary requirements, and it also greatly facilitates machining operations as is well known. That portion of the alloy containing lead is the last to solidify, and therefore fills in the crevices caused by the natural shrinkage of the high melting point constituents of the alloy. A typical composition of gun-metal for pressure work is copper 88.56, tin 5.11 zinc 3.07, and lead 3.23 per cent. It gave 16.16 tons per sq. in. tensile, 7.36 tons of yield point, 27.5 per cent. elongation, and a Brinell hardness of 43. The usual composition of gun-metal for pressure work lies within the following range:—Copper, 84 to 90; tin, 3 to 8; lead, 1.5 to 7.5; and zinc, 3.5 to 7.5 per cent. All the alloys within this range can be made to give excellent results for this class of work. The composition is varied to give some particular characteristic or combination of characteristics for the work in hand. High tin-content gives stiffness and hardness with consequently less rapid machining. The lead gives easy machining and softness proportional to the amount present, and zinc aids casting up to a certain point. With high lead-content trouble may be experienced with lead segregations if the castings are heavy and in such castings the lead should be reduced to 2 or 3 per cent. It may be said that in all pressure work the casting temperature is of vital importance. The best and most economical procedure when castings of a new design are started is to cast four or five boxes at different temperatures and follow these through the shops before any more are cast and afterwards break these up and examine the fractures.

Gating Castings.

Frequently also there is one place and one place only successfully to gate a casting, and careful and logical deductions should be drawn from recorded past experience and the moulder properly instructed and not left to use his own judgment. This, by the way, is not intended as a slur on the brass moulder. It is obvious that the actual moulder cannot be expected to form a correct opinion regarding the best method of gating a casting without the fullest knowledge of the past performances of such castings under test pressure when gated in various ways.

Instruments Necessary.

With reference to casting temperature, it may be said that one of the greatest aids to successful brass founding is the intelligent use of a pyrometer. It is realised that only a comparatively small percentage of brass foundries in this country can afford to make full analyses and physical tests of their castings. There are two instruments which can be used to give information and build up experience of the utmost value. These are the pyrometer and the ball hardness test. Undoubtedly the only possible type of the former for a brass foundry is the base metal bare thermo-couple with a robust indicator. One thermo-couple will give 50 to 80 readings with ordinary use. The cost of the instrument is about £16.

The writer recently checked one of these instruments which has been in constant use for two years in a foundry, and the maximum error over the range was found to be 5 deg. C.

Regarding the ball hardness tester, one of the most useful and inexpensive types is the hand machine operated by a heavy spring. This instrument costs about £9, and gives an impression somewhat similar to that given with a 750 kilos and 10 mm. ball in the standard machine. In fact, the type of instrument is decidedly more useful in a brass foundry than the big machine, as one can check the hardness of jobs any size and in any place.

With a pyrometer, a hardness test, a study of fractures and bend tests, it is possible to build up a knowledge of brass-founding metallurgy of the greatest practical value. Everyone knows that it is not the cost of labour or materials, but the wasters which eat up the profit, and wasters can only be eliminated by careful study and standardised conditions of practice.

Catalogues Received.

Corebinders.—We have received from Messrs. Chemical & Technical Engineering Company, Limited, of 11, Pancras Lane, London, E.C.4, a brochure which they are circularising to the foundry trades. This firm have recently developed a number of binders, as they believe that no one variety can meet every need. No accusation can be levelled against the firm that explicit instructions for use are withheld. A further development in this business is the distribution of a questionnaire to foundries, asking for particulars of the types of sand used so that a suitable binder can be made up to meet the conditions obtaining. The binders are sold under the trade names of Durol, Plastol, Eknol, Corite, Rotex and Vivit.

Pyrometers.—The Cambridge & Paul Instrument Company, Limited, of 45, Grosvenor Gardens, London, S.W.1, are sending out postcards describing a new contact pyrometer for taking surface temperatures up to 400 deg. Fah.

Cast Iron Pipes.—The December monthly stock list of cast iron pipes, distributed by the Staveley Coal & Iron Company, Limited, of Chesterfield, is to hand.

Research Testing.—The Industrial Research Laboratories of the City of Birmingham Gas Department have sent us a wall card, which outlines the type of work undertaken, and includes some useful technical data. The laboratories are equipped for all kinds of heat treatment and the mechanical testing of metals and alloys.

Fireplaces.—Messrs. George Wright (Rotherham), Limited, of Burton Weir Works, Rotherham, have prepared a new brochure dealing with the Vigil and other glow fires. It is beautifully illustrated by coloured plates, and maintains the high standard which one now associates with this firm's advertising matter.

Calendars Received.

Messrs. Armstrong, Whitworth & Company, Limited, of 8, Great George Street, Westminster, are, this year, sending to their customers a wall calendar illustrated with a coloured view taken in one of their departments.

J. HOPKINSON & COMPANY, LIMITED, Britannia Works, Huddersfield, have at present in hand a large order for valves for one of the American electric power stations. This is the fourth large order the company have had from the American Company during the last few years. The present order consists of about 250 valves, the approximate value of which is £15,000 on this side.

STEIN & ATKINSON, LIMITED, 47, Victoria Street, S.W.1, have received an order from the Frodingham Iron and Steel Company, Limited, Scunthorpe, Lincs., for Chapman floating agitators with automatic feeds for fitting to six existing Kerperley gas producers. When the machines now ordered are installed, the Frodingham Company will have a total of 10 Kerperley gas producers fitted with the Chapman agitator.

A Discussion on Pressure-Moulding Machine Practice.

At the November meeting of the London Branch of the Institute of British Foundrymen Mr. A. S. Beech read a Paper on "Continental Foundry Practice." This was published in our issue of November 27. An interesting discussion followed, of which the following is an abstract.

Pressure Moulding Machines.

The BRANCH-PRESIDENT (Mr. V. C. Faulkner), before calling upon MR. A. S. BEECH to read his Paper, said those who had attended the Paris Conference were very grateful to Mr. Beech for the work he had done in securing for them their passports, as well as in other directions. Mr. Beech would speak about pressure moulding, especially hydraulic pressure moulding, which, whatever might be the case in England, was the most important system in Europe, though not in America. He (the Branch-President) had seen as many as 100 hydraulic pressure machines working in one shop on the Continent.

Venting Casserole Moulds.

MR. G. C. PIERCE, who opened the discussion, said that claims had been put forward—and he had heard Mr. Beech put them forward more than once—of the superiority of Continental sands over those used in the British Isles. Mr. Beech had referred to a machine which was making casserole castings; he (Mr. Pierce) had listened very attentively to Mr. Beech at all times when he had been claiming superiority for French methods of working and mixing sands, but he had noticed, from the illustrations of the machines, that there were vent wires attached for the venting of the mould. He would say quite frankly, however, that if he were making the type of casting referred to, he would expect to get it out without venting the mould. If he were right, then surely there must be something wrong; either Mr. Beech was wrong in his advocacy of the superiority of French methods, or he himself was wrong in his contention. At any rate, there were certainly vent wires attached to the machine, and he would say quite emphatically that he would not vent that job

Pattern Plate Making.

MR. A. R. BARTLETT said Mr. Beech had been advocating the hydraulic pressure moulding machine, and one of his illustrations had depicted a core being rammed by pressure, which he had said could not be rammed by jar ramming. Personally, he considered that it could be jar rammed, and under no circumstances would he think of putting a core of dry sand on a job of that description. Mr. Beech, in referring to pattern plates, had also pointed out how economical they were from the point of view of having the metal returned as scrap after the plate had been finished with. But he did not think that the method of making plates indicated was entirely new. It was quite common practice to make pattern plates of that description by hand-moulding the job, then putting a thickness in between in the shape of a frame and pouring white metal into the mould. He remembered that, when he himself had read a Paper in connection with moulding machine practice, he had spoken of the pattern plates being made in that manner, and had illustrated a box and the method on the screen. Mr. Beech had referred to many things that were new to us in England, however. As to the question of venting, as mentioned by Mr. Pierce, he quite agreed, and would under no circumstances think of venting the casserole mould on the top side. If venting was done on the bottom side, he could understand it up to a certain point, but a job of that thickness should not demand much venting.

Cases of One or Two Off Jobs.

MR. H. PEMBERTON complimented Mr. Beech upon his enthusiasm for pressure moulding machines. The pressure moulding machine which had been shown was only for comparatively light work, and he had been hoping that Mr. Beech would have dealt with something of a heavier type. There were several points, however, upon which he sought enlightenment. For instance, could Mr. Beech say what was the minimum number of a particular pattern that he would have mounted on a plate for moulding on those special machines? There were certainly one or two jobs mentioned as being made on the pressure moulding machines which he considered could be done more advantageously on the jar ramming machine. Some years ago he had seen pressure moulding machines used for large work in a foundry at Chesterfield, and he had noticed that for every different mould that had to be made, a different pressure head had to be provided for it. They were making a large pump; there were not many to be made, but they had to make different stools to press between the boxes, between the bars, and he was strongly of opinion that jar ramming would be more advantageous on the larger work. The advantage of jar ramming against pressure ramming was that they could put a pattern on to a jar ramming machine for one or two castings, which could not be put on to the pressure moulding machine. With the latter they were tied to one size of box, whereas with the jar ramming machine, several sizes could be used on the same machine, which was a distinct advantage. For instance, in a case where the work was changing continually during the day, they might be making a cylinder one half-hour, followed by some large flanged blocks, and later by piston heads or similar work—several different types of machines would be required in order to make the different jobs. Therefore, the pressure machine was not so adaptable as the jar ramming machine, but the latter was equally as efficient as the pressure machine for ramming the mould.

Venting and Pressing.

As to the venting of a mould, he believed a job could be made with a jar ramming machine with less venting than with the pressure moulding machine. He remembered that, some years ago in Paris, he had seen a machine which was designed on the principles indicated in the Paper for making railway chairs. He believed, however, that that job had not been done on a pressure moulding machine up to the present time. In the making of a railway chair, there were four cores, and the designer of the machine mentioned had been engaged for about six months in devising a scheme whereby he could vent those cores at the same time that they were being rammed. It had struck him (the speaker) what an ingenious arrangement it was, but he had remarked, "Why vent the cores?" He had also pointed out that at his own works in England thousands of these were made, but they were never vented at all. The designer of the machine had stood rather aghast for the moment, but the venting of the cores for railway chairs was dropped. One of the great disadvantages in connection with a machine for making railway chairs was the taking of the material to and from the machine, which was a very important point. He would be interested to know the minimum number of castings which would justify the use of these machines. Also, he would like to know the diameter of the castings which could be made on the DF4 machine, which he believed Mr. Beech had shown, because he was of opinion that they were of a very light nature. A pressure moulding machine was a very good machine for light work, but for heavier work undoubtedly a jar ram was required, with probably a combination of a press moulding machine as well.

British and Continental Sand.

MR. F. G. CHAMBERS asked, as a user of the pressure moulding machine, if Mr. Beech could indicate the source of the troubles experienced with the machine. The machine in itself had a very complicated valve, which wore badly and went out of action very readily. He understood that the experience in France in connection with these pressure machines was that, owing to the

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incompetence of workmen who used the machines, they were continually requiring the services of a man to put them in order. As Mr. Beech knew the large works in this country, he would realise the difficulty they had to contend with so far as the millwrights were concerned, and often he had to convert himself into a temporary millwright in order to get the machines in order. He was rather interested in the remarks made as to the superiority of the French sands over the English qualities, because, when he had first become associated with the French demonstrators of the machines which he had had put into his shops, the surprise evinced by those demonstrators was such—he was concerned with non-ferrous metals, and not iron—that they were very anxious to take over a sample of the English castings to France, in order to show their confreres what could be done with green sand castings here as compared with dry sand castings in France. He must say a word, however, in commendation of the machine he was working, which was a D.F.4. During the war he was able to produce water pumps at the rate of 126 per day with the pressure machine, whereas he could not possibly have done more than 12 per day with skilled labour. The machine was abused for that particular job. It was designed for work of a diameter of 1 in., but this particular job was one with a diameter of 4 in. Mr. Beech had shown some down-sand frames used on such deep work as this, but this particular job was done without dummies, and by using a little intelligence—it was not all on the French side—he was able to produce at the rate of 126 per day.

Factors in the Speed of Working.

MR. J. W. GARDOM said Mr. Beech had referred to a case in which 350 moulds were put down by two men in eight hours, the moulds containing one core, and another case in which two men produced 400 moulds in eight hours, without cores. He would like to know whether the two men brought their own sand to the machine or whether they had any help. At present he was using hand squeezers, and considered that much of the light work mentioned by Mr. Beech could have been done on a hand squeezer. He would like to know what advantage the hydraulic had over the hand squeezer. There was the difficulty of bringing the sand to and taking the moulds away from the machine. The hand squeezer was more mobile, and could be taken to the work, which seemed to be an advantage, and in his works he was getting from 80 to 100 moulds in eight hours from one man with a hand squeezer. Also, the man was bringing all his own sand, turning it over first thing in the morning, and putting down his own moulds.

MR. PEMBERTON asked what was the distance of the down-sand frame above the joint of the mould; was the distance the same for every mould, or what method was used to determine the distance? Was there a formula for it, or had it to be decided from practical experience?

THE AUTHOR'S REPLY.

MR. BEECH, replying to the discussion, referred first to the questions raised as to the superiority of the Continental sands over British. He did not think he had ever said that Continental sands were superior to British, but it had been insisted upon by many speakers that British sands were not so good as Continental. His experience of the Continental sands was that they were extremely full of clay—in France, at any rate—and in order to get a good casting the sand had to be opened. To do that, in his firm's foundries in France it was customary to use the sand very dry, ram it very hard, and add a proportion of sea sand, so obtaining a natural vent in the sand. As to the wire vented casserole casting mentioned by Mr. Pierce, he quite agreed personally, and would not vent such a mould, but it had to be remembered that the job had to be made for foundrymen and customers who insisted that it must be vented. Consequently, his firm had devised what he considered to be a very ingenious arrangement for venting the job at the same time as it was squeezed. The vent wires came down into the box at the same time, and were on both sides of the mould; the customers were so keen on venting that they had them vented both on the cope and the drag sides. Mr. Bartlett had mentioned the core on a casting made in England. It was a deep, straight, vertical core, without any taper. The only trouble there was that if it were rammed up on a jar ramming machine, there would be uneven ramming on the core and hardness at the top, and therefore it was much better to have it made on the pressure machine, where more even ramming would be obtained and much easier and safer pattern-drawing.

MR. BARTLETT did not think so.

MR. BEECH replied that he and Mr. Bartlett would have to differ. With regard to pattern plates, he believed Mr. Bartlett was confusing the split pattern plate and the match plate. He quite agreed that the match plate made in white metal was very simple, and that this method was very old, *i.e.*, making a cope and drag and putting a distance piece between the two moulds. The split pattern, however, made with a stripping plate, and made up with cement at the back, was a very different proposition, and although it was not new—because his firm had brought out the system in France some years ago—it had been considerably developed since it was first introduced. Thus, the making of the split pattern plate, internally or externally, and at the same time making core-boxes on the same system and not machining them, would enable foundrymen to make metal boxes at practically the same price as a wooden box. Mr. Pemberton had expressed the opinion that the hydraulic moulding machine should be used for light work only. He, however, as a result of the Paris Congress, and the fact that a number of gentlemen from this country had attended, he had received a large order from a North of England firm for machines capable of ramming up a job with about 18 to 19 in. depth on one side. The moulding box would be about 4 ft. 6 in. or 4 ft. 8 in. dia. or square. The down-sand frame was used for ramming.

A job 5 ft. deep could not be made on a squeezer machine. As he had said in the Paper, he quite agreed that, for large moulds of deep and simple castings, where the pattern-drawing was of secondary consideration, or where there were only a few moulds required off a pattern, the jolting machine was to be recommended—the finishing or patching to be done by hand. As to the minimum number of castings to be made on these machines economically, that question was very difficult to answer, because it depended upon each job. In all moulding machines, of whatever type—whether jar ramming or squeeze machines—the more difficult or intricate the job, the more the saving in actual cost compared with hand methods. In the case of a simple job, it was very much more difficult to compete with the hand moulder than in the case of a difficult job. For example, an automobile cylinder was difficult to mould by hand, but in that case a machine would beat a hand moulder by a much larger percentage than in the case of a simpler job. With a F4 or DF4 machine, it could be taken that, as a rule, 100 moulds would pay for the job, including the pattern-plate, which was very simple. If, however, a split pattern-plate were used, there must be considerably greater quantities. A standard job could be put on the machine, taken off and put on again when necessary, but when a split pattern-plate was used, everything depended on the frequency of the job. Reference had been made to the pressure head used in a foundry at Chesterfield. There, again, if the patterns were being changed continually, and there were only a few castings to be made from one pattern, that was not a job for a squeezer machine; it could be done much better on a jolt ramming machine. On the other hand, a wooden pattern could be put on the squeeze machine, just in the same way as on the jolting machine, so long as it had a flat back.

Railway Chair Making.

Mr. Pemberton had said that jar ramming machines were equally as efficient as squeeze machines for ramming a job, but surely he did not expect him (Mr. Beech) to admit that. His firm made jar ramming machines, but the whole point of his lecture was to show the improvement

effected by the squeeze machine. The problem of railway chairs was very interesting. Some time ago, in France, he had seen railway chairs being made on a moulding machine, but whenever one tried to introduce moulding machines to a railway company, they asked first whether one could make railway chairs on the type of machine in question. If the reply was in the affirmative, one would be shown a man and a boy putting down 200 a day in the railway company's foundry. The experience in France was that, before the war, they had a number of men who put down as many as the British did. Now, however, the men in France had become independent, and there was great difficulty in getting men to replace those who did this work before the war. Consequently they had had to go back to machines. His firm had machines working in France with five castings in a moulding box, and by doing that they could just about beat the men in a day's output; they could beat the men by about 5 or 10 moulds, but it was a very grave question whether or not it was advisable to instal such a machine, because it must be recognised that there was the purchase price of the machine to be considered, as well as interest on capital, depreciation, power for working the machine—which was practically negligible, but still it was there—and various other items, and it was much better, where we could get 200 moulds per day from the men, to continue with that method. As to the difference between the DF4 and the F4 machines, in the DF4 the mould was pushed completely through the box, and in the other the mould was in the box. The machines were designed for light shallow work—for a job of from 2½ to 2¾ in. as a maximum—and it rammed the cope and drag simultaneously. Mr. Chambers, during the war, had done some wonderful work with those machines, and when he had seen it, he could not possibly have expected that it was made on those machines if Mr. Chambers had not given his word. It was work quite outside the scope of the machine, and yet it was done quite successfully at Derby.

Deep Work.

Deeper work could be made on the squeezer machine in three different ways. The first way was by judiciously removing sand from the mould over the top of the high parts in the pattern. The second way was by using a dummy ramming block, and by taking two or even, if necessary, three squeezes with the dummy and ramming down carefully. The third way was by the use of the down sand frame. The depth of the down sand frame would depend on the job to be rammed, how deep one wanted to go, and how much sand one had to ram. One had to determine in the first place how much sand one needed in order to get the proper ramming in the mould, and when that was done, one fixed the frame at the desired level and brought it up or down as required; the distance was determined by experience. The British Thomson-Houston Company had adopted this process at Rugby on very deep jobs. They had what was practically tantamount to the down sand frame. The first time they had used it, they had smashed the moulding box and down sand frame, as the ramming at the bottom was very great, and yet they also got ramming from the top, bottom and sides.

The Question of Sands.

Sands in England were extremely good, but he had found that people in this country would not take the trouble to prepare them. He had seen them depend more on the water bucket for giving them a bond than upon the mill. If, however, they did not get the natural elements out of the sand, they would not get results. In the railway brass foundries at Derby they had very good sand indeed. Another place where very good sands were used was at the foundries of British Insulated and Helsby Cables, at Prescot, whose castings compared favourably with French castings in finish and skin. Also very good sand and excellent clean castings were obtained by Messrs. W. & T. Avery, of Birmingham; they all adopted the system of exercising great trouble with the sand in preference to excess fettling, and they considered it paid in the end.

Output Considerations.

The method of working machines in France was this. In the first place, an expensive machine was used; continuous working must be maintained, because of the cost of idle time, and consequently they had a separate gang to bring the sand and metal to the machine, which latter worked all day. The foundries were split into watertight compartments, there being one man preparing sand, another conveying it to the mould, and taking it back again, and so on.

MR. GARDOM asked Mr. Beech if he could give a figure of the moulds per man per hour, *i.e.*, including all labour, the bringing of the sand to the mould, and everything else.

MR. BEECH said he could not, because he had had no experience of Mr. Gardom's works; all he could say was what the machine was actually capable of ramming per hour. Mr. Gardom knew how long it took to convey the sand to the machine in his own foundry, and could ascertain whether there was any advantage in having a machine or not, but, naturally, the output of the machine depended on a number of factors. For instance, it depended on the organisation of the foundry, the speed with which the sand could be conveyed to the machine, the speed at which the moulds could be taken from the machine to the floor, and so on. The main factor was the manner in which the men were paid, whether by piece work or day work, and such factors, which were absolutely beyond the control of the makers of the machines. The machines would ram up one mould per minute easily—that is, ram the mould, draw the pattern and put it on the floor in a minute—but after that it was a question of man power, which was outside the control of the makers of the machines.

Vote of Thanks.

MR. WESLEY LAMBERT, in proposing that a very hearty vote of thanks be accorded Mr. Beech for his very interesting Paper, said he had refrained from entering into the discussion.

With reference to the making of the casseroles which Mr. Beech had mentioned, and regarding the venting, of which comments had been made in the discussion, he had watched the manufacture of these articles, and, if he remembered rightly, the machines actually in use in M. Ronceray's foundry carried a large number of venting wires; as a matter of fact, actually similar to the illustration thrown on the screen that evening. He did not know whether these machines were merely operating for demonstration purposes, but he was under the impression that these casseroles were being made by M. Ronceray as a commercial proposition. If this was so, then a very large number of venting wires were arranged on the machine.

MR. BEECH said the venting wires were arranged on the machine by request of the customer, and the machines which Mr. Lambert saw in France were erected for the purpose of demonstrating their efficiency to the customer by whom those particular machines were ordered.

MR. LAMBERT said he was under the impression, judging from the number of casseroles being made at the time of his visit, that these articles were being made for sale by M. Ronceray, and it was not explained to him at the time that the venting wires were not considered essential. He again expressed his personal thanks to Mr. Beech for his Paper, and repeated his proposal of a hearty vote of thanks to the lecturer.

MR. H. O. SLATER seconded, and complimented Mr. Beech on the way he had dealt with the Paper. There were many points of interest raised, but sometimes the smallest details, which were important, were missed. Mr. Beech's illustration on the screen of the jar ramming machine ramming hard on the face and soft at the back was right in principle in one way and wrong in another. If he made the mould hard on the face by jar-ramming, and then took it off the machine and turned it over, the face became the top joint, and therefore it was hard on the top and soft on the bottom, which should be the harder.

The vote of thanks was accorded with acclamation, and Mr. Beech suitably replied.

Trade Talk.

JOHN DUGDILL & COMPANY have removed from Failsworth to Hazel Grove, near Stockport.

ARCHIBALD LOW & SONS, LIMITED, are establishing offices at 51, North John Street, Liverpool.

MR. HAYDN T. HARRISON, consulting engineer, has removed from 11 to 14, Victoria Street, London, S.W.

MR. D. HOOPER has established himself in business at Lime Grove, Long Eaton, Derbyshire, as an engineers' agent.

AN OUTBREAK OF FIRE recently occurred at the Blochairn Works, Glasgow, of the Steel Company of Scotland, Limited.

LORD, PICKARD & COMPANY, of Exeter, have been appointed agents for Robinson & Hands Electrical Company, Limited, Birmingham.

IT IS STATED that the Spanish Government has approached Vickers, Limited, with a view to their erecting armaments plant in Spain.

CROSSLEY BROS., LIMITED, of Manchester, have acquired the business of the Saunderson Tractor & Implement Company, Limited, Elstow.

BEYER, PEACOCK & COMPANY, LIMITED, have an order from the Union of South African Railways for twenty locomotives of the "Garratt" type.

H. W. SULLIVAN, LIMITED, have appointed S. Glover & Company, 13, Akenside Hill, Quayside, Newcastle-on-Tyne, as their agents in the Northern Counties.

MR. W. W. ADAMS has been appointed agent in Liverpool and North Wales for the Shaw Hardware Company, Limited, Castle Street, Wolverhampton.

THE MACHINE TOOL DEPARTMENT of W. Dederich, Limited, Imperial Buildings, Ludgate Circus, London, E.C.4, has been acquired by Soag Machine Tools, Limited.

FIRE BROKE OUT recently at the works of the Roller Boiler Company, Limited, of Rotherham, but was not serious enough to interfere with the company's normal operations.

RICHARD HILL & COMPANY, LIMITED, have decided to electrify their rolling mills, to modernise the furnace plant, and also to reconstruct the wire rod rolling mill.

THE ANNUAL DINNER of the Birmingham Metallurgical Society was held at the Queen's Hotel on December 1, Mr. H. B. Jacks (President of the Society) in the chair.

MR. H. A. PEARSON, London representative of Allen West & Company, Limited, and the Reason Manufacturing Company, Limited, has removed to 176 Upper Thames Street, E.C.4.

W. H. GOLD, LIMITED, steel, tinplate and machinery agents, have removed from 85, Gracechurch Street, to Norfolk House, 7, Laurence Pountney Hill, Cannon Street, London, E.C.4.

MR. T. C. ALEXANDER has established himself in business as an electrical and mechanical engineer at 67, Hope Street, Glasgow, under the style of Turnbull Alexander & Company.

AN OUTBREAK of fire occurred recently in the shipbuilding and engineering yard of John Lewis & Sons, Limited, at Point Law, Aberdeen, considerable damage being done to the fitting shop and the erecting shed.

HARLAND & WOLFF, LIMITED, propose building 19 motor ships, six of which have already been laid down at their Govan shipyard. The guarantee of a loan of £1,800,000 has been secured under the Trade Facilities Act.

LICENCES UNDER THE Non-Ferrous Metal Industry Act, 1918, have been granted by the Board of Trade to the undermentioned: Dick & Company, W. J., 14, Chapel Walks, Liverpool; Silberschmidt, Hermann, 30, Fenchurch Street, London, E.C.3.

A CONSIDERABLE DEVELOPMENT of the South African steel industry is likely to result from the acquisition of an interest in the Dunswart Iron & Steel Works, Limited, by Head, Wrightson & Company, Limited, of Thornaby-on-Tees. Additions to the plant are being made.

MR. BRADFORD, manager of the Broken Hill Company's steel works at Newcastle, N.S.W., has stated that a considerable quantity of steel is entering Australia at a price lower than it costs the English manufacturers to produce. British industrial concerns are faced with the choice of a loss by selling at these prices or a bigger loss by closing down. Mr. McDougall, the manager of Rylands Wire Works, also stated that wire netting manufactured in England from Continental material was shipped from Liverpool at 55 per cent. lower than the price at which the British farmer could purchase it. By reason of this dumping the same wire netting could be placed on the Australian market at a price 5 per cent. lower than the Australian manufacturer could produce it.

BRITISH PIG-IRONS, LIMITED, Abbey House, 2, 4, 6 and 8, Victoria Street, Westminster, London, S.W.1, owing to expansion of business, have secured more commodious office accommodation on the first floor of the same building, and propose taking possession about December 15.

SWANSEA ELECTRICITY COMMITTEE has accepted a tender of the British Thomson-Houston Company, Limited, for a 10,000 kw. turbo-alternator at £35,097. As an instance of the extent to which prices have fallen, it was stated that the same kind of turbo-alternator supplied by the company two years ago cost £48,000.

HAVING A CONTROLLING INTEREST in the North Wales Power Company, the Aluminium Corporation, Limited, will benefit considerably in the immediate future. During the year the Aluminium Corporation, Limited, have supplied the North Wales Power Company with over 5,000,000 units of electrical energy, and in the course of 1924 there is likely to be a large increase in the demand. The Power Company have been granted a Government guarantee of over £1,500,000 to enable them to develop further their water power and extend their transmission lines over an area of some 4,000 square miles. The corporation's hydro-electric works are at Dolgarrog, in the Conway Valley of North Wales. With the completion of the new power-house and pipeline, by March next, the corporation's output of power will be greatly increased.

THE 28TH ANNUAL DINNER of the Institute of Marine Engineers was held on November 30, Viscount Curzon, president of the Institute, in the chair. The company included: Sir James Mills, Sir Charles Morgan (president of the Institution of Civil Engineers), Mr. J. Herbert Scrutton (chairman of Lloyd's Register of Shipping), Mr. T. Carlton (Engineer-in-Chief to the Board of Trade), Sir Westcott S. Abell (Chief Ship Surveyor to Lloyd's Register of Shipping), Mr. Andrew Scott (Secretary to Lloyd's Register of Shipping), Mr. V. C. Faulkner (Institute of British Foundrymen), Mr. F. W. Bridges, Mr. J. Havelock Wilson, Mr. James Adamson (hon. secretary to Institute of Marine Engineers), Mr. H. H. Horsburgh, Messrs. Robert Williamson, Geo. Adams, H. Walker, R. Leslie, F. M. Timpson, J. Carnaghan, J. Silley, Jas. M. Dewar, H. Rennie, B. P. Fielden, H. Puffett, C. S. Glen Walker, T. H. Ellis, G. James Wells, and Arthur T. Quelch.

Book Review.

Boiler Chemistry and Feed Water Supplies. By J. H. Paul, B.Sc., F.I.C. Published by Messrs. Longmans, Green & Company, 39, Paternoster Row, London, E.C.4. Price 14s. net.

Books on boilers and steam raising are usually written by mechanical engineers, and contain much arithmetic showing how to calculate efficiencies. This book deals with the subject purely from the chemical aspect, which makes it especially interesting for steel and iron works chemists, who are called upon from time to time to make analyses.

The author puts forward in Chapter XI his views on corrosion from the chemical point of view. In view of some national research which is now being prosecuted his views may be wrong, but they are such that they can be readily followed by the average chemist, and an avenue is indicated which, being followed, holds out hope of immediate cure, and not in ten years' time, which is the time allowed for the appreciation of some work of an allied character. Theory, even if academically incorrect, when it is translatable into practice, is always useful. We commend this book to the chemists who are attached to large industrial concerns.

Conversion of Clays to Aluminium Sulphate.—In connection with the development of a simple cheap process of preparing pure solutions of aluminium sulphate, work has been undertaken at the Pacific Experiment Station of the U.S. Bureau of Mines on sulphating clays by various methods. Sulphate roasting, using gases containing varying amounts of sulphur dioxide to sulphate the aluminium silicate of the clays proved impracticable, but favourable results were obtained by treating the clays with sulphuric acid. A wide series of aluminium silicate products was treated at various temperatures with differing strengths of acid. In general, nearly all the silicates were decomposed with fair efficiency at temperatures up to 200 deg. C., and with acids containing 50 per cent. to 70 per cent. sulphuric acid. The easiest silicate to decompose was bentonite, but many of the Kaolins were quite easily attacked. Feldspars are much more resistent.

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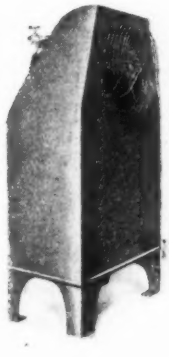

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IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—With the subsidence of election excitement, the Cleveland iron market has resumed business, and though, in view of the near approach of the Christmas holiday, buying is practically suspended over the remainder of the year, the tone continues steady, with smelters as a rule holding well-filled order-books fully absorbing outputs over the first quarter of the year. The somewhat confused political situation at the moment may, however, have a disturbing effect upon prospective business on future account, while consequent upon recent heavy purchases in advance there is little prompt iron now available for immediate disposal. Meanwhile, prices are firmly held all round at late levels. No. 1 is 107s. 6d., No. 3 G.M.B. 100s., No. 4 foundry 99s., and No. 4 forge 98s. per ton. During November five furnaces were put into operation on the North-East Coast, bringing the total to 44, distributed as follows: Cleveland iron, 14; hematite, 12; basic and other kinds, 18.

The situation in the hematite market continues firm, but with little prompt iron obtainable, values disclose increasing strength, mixed numbers of East Coast qualities realising fully 102s. 6d. per ton, with 1s. per ton extra for No. 1 brands. Forward sales of mixed numbers are now being negotiated on the basis of 103s. 6d. per ton. Export business remains quiet. In West Cumberland and North Lancashire prices are firm at the old figures, Bessemer mixed numbers being quoted at 115s. per ton delivered at Glasgow and Sheffield, and 120s. per ton at Birmingham. Low-phosphorus iron is in steady request.

MANCHESTER.—Conditions in the Lancashire area may be reported as improving, the tone of the local markets bearing fewer traces of the pessimism as to the future prospects of the iron trade than have been in evidence of late. Lancashire iron founders are not, however, so busy as their recent purchases of pig-iron might seem to suggest. These were, it seems, largely anticipatory of the orders for castings which they expect to obtain next year, and until these orders are secured they do not seem in a hurry to buy the iron which will be required for mixing purposes. There is now no pig-iron to compete with the Derbyshire brands for use in Manchester, which is now quoted 102s. for foundry quality, delivered.

THE MIDLANDS.—The feature attracting most attention just now in the Birmingham market is the revival of demand for forge qualities of pig, while business in foundry iron remains as quiet as previously noted. It would appear, however, that consumers of foundry iron, having satisfied their immediate forward requirements, are in no hurry to book fresh commitments, and consequently buying meantime is restricted. Quotations remain firm, as follow:—Northamptonshire No. 3 foundry, 93s. 6d.; Derbyshire No. 3 foundry, 93s. 6d. to 95s., all net f.o.t. furnaces.

SCOTLAND.—An increasing volume of transactions in Scotch pig-iron indicates the impression in trade circles that business is distinctly on the mend, while prices are very firm. The minimum makers' price for No. 3 foundry is now 107s. 6d. at furnaces, and if delivery is wanted into next year some of the makers are asking as much as 110s., and not particularly keen to make a large book even at that figure.

Finished Iron.

The general improvement recently noted in the manufacturing branches of the trade is well maintained, and although in some departments only partial employment is still possible, the bar mills are fairly engaged, especially on best-grade material. The position has been favourably affected of late by the distribution of some substantial engineering contracts, while several very good railway orders for home and export are understood to have been recently given out, and the outlook is much more satisfactory than it has been since the early spring of this year. There are also anticipations of further railway work being shortly placed with makers. Of course, marked bars and merchant bars are feeling the benefit of the improved demand. There is no appreciable change in the demand for gas strip, however.

Steel.

In this market the most active demand is that for basic billets, while there is also a general improvement of buying in other sections of the steel trade, with an advance in quotations for that particular quality of semi-products to £8 15s. delivered Sheffield. This figure makes the rise fifteen shillings in a month. There is some talk of hard basic billets, as well as acid qualities, costing more very shortly, but at present the quotations remain as hitherto. Makers of open-hearth steel are becoming busier, while crucible-steel manufacturers report some improvement. There is a fairly heavy and expanding demand for alloy steel for motor construction. Heavy railway orders for rails, etc., are being placed in this district, and all round the feeling of depression seems to be passing. A steady business has been done in tinplates during the past week or two, with prices very firm all round. Sales of second-hand parcels have been made at 23s. 9d., but quite a considerable trade is reported for January to March on a basis of 24s., and makers are by no means keen on going on even at this, owing to the uncertainty in values of raw materials and the possibility of a rise in wages.

Scrap.

The increased demand for most descriptions of ferrous scrap noted in recent reports has now slightly abated in view of the impending holidays, but as stocks in consumers' yards generally are on a limited scale, it is fairly safe to predict a revival of active buying when the turn of the year has been reached. Meantime there is a further considerable improvement in the steel scrap trade, and in some districts good heavy melting scrap is getting quite scarce. Reports are current of 105s. per ton being paid for such scrap in South Wales, and although the Sheffield consumers are not paying quite so much, they are giving a good deal more than formerly, up to 95s. per ton delivered. There is, however, a considerable variation in prices of cast-iron scrap according to locality, this quality, for instance, being sold at from 80s. to 85s. per ton in one place, while in another as much as 100s. is being paid. With the common qualities of pig-iron at 100s. in most districts where it is consumed, it is rather absurd that good cast-iron scrap should ever be sold at 85s.

Metals.

Copper.—The tendency of values in the standard market has evidenced remarkable steadiness round about £62 per ton, the occasional fluctuations marked seldom ranging beyond a few shillings either way. Statistically, in spite of the enormous production, the position appears quite sound. The demand for copper is increasing and this is well shown by the fact that exports from the United States during the past three months amounted to 104,000 tons. On this basis the foreign exports, in spite of the impoverished condition of the world, are greater than they have ever been, with the exception of the year 1917. Current quotations:—*Cash*: Thursday, £62 5s.; Friday, £62 12s. 6d.; Monday, £62 15s.; Tuesday, £62 7s. 6d.; Wednesday, £62 5s. *Three Months*: Thursday, £63; Friday, £63 5s.; Monday, £63 10s.; Tuesday, £63 2s. 6d.; Wednesday, £63.

Tin.—The market for standard tin had considerable strength, but latterly there have been downward fluctuations, which, so far, have had no adverse effect upon the stability of the position. The statistics for November, appended, may be regarded as further strengthening market conditions, while substantial support coming from America may be anticipated as favourable to bull developments in the near future.

Ricard & Friewald's statistics of tin for November are as follows:—

STOCKS, LANDING AND AFLOAT, EUROPE AND AMERICA: U.K.—Stocks in London, 1,915 tons; stocks in other ports, 1,866 tons; total, 3,781 tons. Landing and in transit, 765 tons; afloat from Straits, 1,720 tons; afloat in Australia, 92 tons; total U.K., 6,358 tons. Holland, Banca spot, 1,785 tons; Banca and/or Billiton afloat to Europe and America, 374 tons; Straits spot, —; Hamburg spot, —; Continent, Straits afloat, 665 tons; U.S. spot and landing, 1,072 tons; afloat, 6,655 tons; total visible supply, 16,909 tons.

Current quotations:—*Cash*: Thursday, £238 15s.; Friday, £238 10s.; Monday, £230 10s.; Tuesday, £229 10s.; Wednesday, £237 5s. *Three Months*: Thursday, £239 17s. 6d.; Friday, £239; Monday, £231 15s.; Tuesday, £230 15s.; Wednesday, £238 10s.

Spelter.—Though demand for home consumption has been on a reduced scale, the market for this metal has remained fairly steady, with quotations firm on the whole. Towards the close, however, realisations on speculative accounts had a slightly weakening tendency, and values showed some reaction. Current quotations:—*Ordinary*: £32 8s. 9d.; Friday, £32 10s.; Monday, £32 5s.; Tuesday, £32 6s. 3d.; Wednesday, £32 6s. 3d.

Lead.—The market for soft foreign pig continues fairly active, with values firm for prompt and forward transactions. There has, however, been some selling by speculative operators, but this has been counteracted by a heavy consumptive demand. Current quotations:— *Soft foreign (prompt)*: Thursday, £30 17s. 6d.; Friday, £30 12s. 6d.; Monday, £31 2s. 6d.; Tuesday, £31 5s.; Wednesday, £31 8s. 9d.